Vol. 3. DECEMBER, 1916 No. 10.

JOURNAL
OF THE
BOSTON SOCIETY
OF
CIVIL ENGINEERS

Published monthly, excepting July and August, by the Society,
715 Tremont Temple, Boston, Massachusetts.

Entered as second-class matter, January 15, 1914, at the Post Office at Boston, Mass.
under Act of August 24, 1912.

Subscription Price, $4.00 a year (Ten Numbers)
50 Cents a Copy

Copyright, 1916, by the Boston Society of Civil Engineers.

BOSTON SOCIETY OF CIVIL ENGINEERS

OFFICERS, 1916-1917

PRESIDENT
RICHARD A. HALE

VICE-PRESIDENTS

RALPH E. CURTIS (Term expires March, 1917)	LEWIS M. HASTINGS (Term expires March, 1918)

SECRETARY AND LIBRARIAN	TREASURER
S. EVERETT TINKHAM	FRANK O. WHITNEY

DIRECTORS

EDMUND M. BLAKE (Term expires March, 1917)	GEORGE C. WHIPPLE (Term expires March, 1917)
ARTHUR W. DEAN (Term expires March, 1918)	SANFORD E. THOMPSON (Term expires March, 1918)

PAST PRESIDENTS
(Members of the Board)

FREDERIC H. FAY HARRISON P. EDDY CHARLES R. GOW

SPECIAL COMMITTEES

ON THE LIBRARY	ON MEMBERSHIP
S. EVERETT TINKHAM, Chairman	CHARLES R. GOW, Chairman
HENRY F. BRYANT	BURTIS S. BROWN
FREDERIC I. WINSLOW	EDWARD F. ROCKWOOD

ON PUBLICATION

CHARLES W. SHERMAN, Chairman
GEORGE A. CARPENTER GEORGE C. WHIPPLE
DE WITT C. WEBB SANFORD E. THOMPSON
ARTHUR W. DEAN

Editor — EDWARD C. SHERMAN
6 Beacon Street, Boston

Vol. III DECEMBER, 1916 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, DECEMBER 20, 1916,

at 8 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. Arthur E. Morgan, president of the Morgan Engineering Companies, of Dayton, Ohio, will present an illustrated paper on "Flood Control in the Miami Valley."

S. E. TINKHAM, *Secretary.*

PAPER IN THIS NUMBER.

"The Portland Bridge." E. E. Pettee.

CURRENT DISCUSSION.

Paper.	Author.	Published.	Discussion Closes.
"Effect of Channel on Stream Flow."	N. C. Grover.	Nov.	Jan. 10

Reprints from this publication, which is copyrighted, may be made provided full credit is given to the author and the Society.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

Boston, Mass., November 17, 1916. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, and was called to order at 8.30 o'clock by the President, Richard A. Hale.

There were 65 members and visitors present.

The record of the last meeting was approved as printed in the November Journal.

The President announced the deaths of the following members of the Society:

Edward D. Bolton, died March 10, 1916; William C. Cuntz, died November 2, 1916; and John W. Ellis, a past President of the Society, who died October 30, 1916.

By vote, the President was requested to appoint committees to prepare memoirs of our late associates named above. The President has selected the following committees to prepare the memoirs:

That for memoir of Mr. Bolton, Messrs. Frederic M. Hersey and Daniel W. Pratt.

That for memoir of Mr. Cuntz, Messrs. Charles S. Clark, Benjamin W. Guppy and Gilbert S. Vickery.

That for memoir of Past President Ellis, Mr. John R. Freeman.

Mr. Nathan C. Grover then read the paper of the evening, entitled, "Effect of Channel on Stream Flow." The paper was illustrated with lantern slides. In the discussion which followed, the following participated: Dwight Porter, Dana M. Wood, Frank B. Sanborn, C. H. Pierce and President Hale.

Adjourned.

S. E. Tinkham, *Secretary.*

Boston, Mass., November 1, 1916. — A meeting of the Sanitary Section of the Boston Society of Civil Engineers was held this evening at 7.45 o'clock, in the Society library, Tremont Temple. In the absence of the chairman, Mr. Edward Wright, Jr., Vice-Chairman, presided.

The subject for discussion was "Catch-Basin Construction and Maintenance," and discussion was opened by Mr. George A. Carpenter, city engineer, Pawtucket, R. I., who described the improvements in catch-basin cleaning methods, which have been adopted at Pawtucket, and especially a description of the motor truck, which has been developed by him, for cleaning catch basins in an efficient and economical manner.

The subject was also discussed by Messrs. Lewis M. Hastings, Edgar S. Dorr, George H. Nye, David A. Ambrose, Philip W. Taylor, Gordon H. Fernald and Henry A. Varney. A number of letters containing information and discussions concerning catch basins were received, but were not presented on account of the lack of time and also because the intention is to collect all of the available material for discussion in the JOURNAL.

In connection with the above discussion, lantern slides, drawings and photographs were used to illustrate catch-basin construction and methods of cleaning. A number of opaque objects, such as drawings and photographs, were projected on the screen by means of the lantern, and the results were fairly satisfactory for use in a small room. In order that the whole object shall be clearly illustrated and brought into focus, such drawings or photographs should not be over six inches square. Drawings should be made on white drawing paper or bristol board, and the lines should be bold and show considerable contrast. Colors can be used to bring out sections or other details more prominently.

The meeting adjourned about ten o'clock. There were 60 present.

FRANK A. MARSTON, *Clerk.*

RULES RELATING TO REPRINTS OF PAPERS AND DISCUSSIONS.

1. Authors of papers published in the Society's JOURNAL will receive, free of charge, 50 reprint copies of their papers as originally printed in the JOURNAL, in pamphlet form, with covers. Additional reprints, if ordered before publication of the JOURNAL, may be had at the actual cost of paper, press-work and binding.

2. Members of the Society and other persons taking part in discussions shall be entitled to receive, without charge, 3 copies of the JOURNAL in which the discussion is printed, on application to the Secretary.

3. Members can be supplied with reprints of a discussion, at cost, if order is placed before the publication of the JOURNAL containing it.

4. Persons who present written discussion may, at the discretion of the Committee on Publication, be entitled, without charge, to receive not exceeding 25 reprints of the entire discussion published in a single issue of the JOURNAL.

At a meeting of the Board of Government held November 15, 1916, the above rules were adopted.

S. E. TINKHAM, *Secretary.*

NEW PUBLICATION.

WATER-SUPPLY PAPER 415. "Surface Waters of Massachusetts." By C. H. Pierce and H. J. Dean, 1916. 430 pages, 12 plates, 6 text figures.

This volume contains the results of stream-flow investigations in Massachusetts, and a compilation of the available records. The data are arranged on the basis of the "climatic" year ending September 30, that being the division of the year now generally used by the Geological Survey throughout its work of water resources investigations. The report contains an introduction by Nathan C. Grover, briefly sketching the uses and development of the water resources of Massachusetts, which have at all times played an important part in the industrial and commercial development of the Commonwealth. An article on "Topography," by Arthur Keith, outlines the geologic formations of Massachusetts with especial reference to the various drainage basins, and gives a bird's-eye view of the surface conditions with a non-technical discussion of the different geologic episodes which have contributed to the formation of the river systems. The tables of discharge, showing the flow of the rivers as measured at the gaging stations, are followed by a gazetteer of streams which lists and describes all the streams, lakes and ponds shown on the topographic maps of Massachusetts. A contour map (in pocket) at a scale of 1 : 250,000 (about four miles to the inch) printed in colors shows the principal drainage basins and location of gaging stations. Long-term records of the flow of the Merrimack River at Lowell as compiled by A. T. Safford, and at Lawrence, compiled by R. A. Hale, are printed in this report.

APPLICATIONS FOR MEMBERSHIP.

[December 5, 1916.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

BABCOCK, JOHN BRAZER, 3d, Watertown, Mass. (Age 27, b. Boston, Mass.) Graduate of Mass. Inst. of Technology, 1910, civil engineering course, degree of S.B. From 1910 to 1911, assistant engineer on maintenance, with Grand Trunk Railway, Toronto, Canada; from 1911 to 1912, instrumentman on construction, with Canadian Pacific Railway, Perth, Ontario; from 1912 to 1913, resident engineer, Southern New England Railway, Miliville, Mass.; from 1913 to 1914, resident engineer with Ambursen Hydraulic Construction Company of Canada, on construction of hollow reinforced concrete dams; from 1914 to 1915, designing engineer with same company; during winter of 1915–16, engineer-assistant, Terminal Commission, Boston, Mass.; is now instructor in civil engineering at Mass. Inst. of Technology. Refers to C. F. Allen, C. B. Breed, J. W. Howard, L. E. Moore and C. M. Spofford.

HORTON, FREEMAN HUDSON, Jamaica Plain, Mass. (Age 19, b. Bradentown, Fla.) Student for one year at North Carolina University, and is now third-year student at Mass. Inst. of Technology. Refers to A. E. Burton, G. L. Hosmer, J. W. Howard, H. B. Luther, A. G. Robbins and G. E. Russell.

REED, LESLIE P., Charles River Village, Mass. (Age 26, b. Hyde Park, Mass.) Student at Lowell Inst. for Industrial Foremen from 1910 to 1911, and at Franklin Union, 1913. From September, 1908, to March, 1916, assistant to William S. Johnson, in office, on surveys, and on construction; is now assistant superintendent with Bay State Dredging & Contracting Co., Boston, on Wellesley Extension, Metropolitan High Level Sewer, Needham, Mass. Elected a junior, March 19, 1913, and now desires to be transferred to grade of member. Refers to F. S. Bailey, C. R. Gow, W. S. Johnson and J. E. Palmer.

SAWYER, GEORGE SUMMERS, Fall River, Mass. (Age 26, b. Charlestown, Mass.) Graduate of Mass. Inst. of Technology, 1912, civil engineering course. From 1912 to 1914, assistant in civil engineering department, Mass. Inst. of Technology; from June, 1914, to date, assistant engineer with H. K. Barrows on construction and topographical survey work. Elected a junior, October 21, 1914, and now desires to be transferred to grade of member. Refers to H. K. Barrows, C. B. Breed, J. F. A. Leonard, C. A. Moore and A. L. Shaw.

TOMASELLO, JOSEPH A., Dorchester, Mass. (Age 29, b. Messina, Italy.) Educated in Boston public schools. From 1903 to date, with A. G. Tomasello; began as timekeeper on construction, and since 1908 has been superintendent of construction and partner; is now building bridge at Watertown for Metropolitan Park Commissioners. Refers to R. C. Allen, D. A. Ambrose, C. R. Gow and Hugh Nawn.

LIST OF MEMBERS.

ADDITION.

WADE, WM. NEWELL	P. O. Box 3215, Boston, Mass.

CHANGES OF ADDRESS.

BORDEN, J. EDGAR	49 Orchard St., Portsmouth, N. H.
DELONG, HAROLD C.	135 University Rd., Brookline, Mass.
DROWNE, HENRY B.	35 Kimberly Ave., Springfield, Mass.
ELLIS, LESTER F.	52 Waltham St., Lexington, Mass.
FARWELL, JOSEPH W., Jr.	Norfolk St., Needham, Mass.
FEHR, GORDON	University of Toronto, Toronto, Ont.
GALLENE, VICTOR J.	13-21 Park Row, New York, N. Y.
GLADDING, RAYMOND D.	Box 422, Wilson, N. C.
HOLWAY, WM. R.	North Scituate, R. I.
HUNTINGTON, FREDERICK W.	14 Appleton St., Lowell, Mass.

Jeffers, Robert B. ....55 Beacon St., Rochester, N. Y.
Johnson, Frank W. ....822 New Birks Bldg., Montreal, Canada
Mead, Royal L. ....125 Prescott St., E. Boston, Mass.
Powers, Wm. J., Jr. ....31 Varnum St., Arlington, Mass.
Smulski, Edward ....136 Federal St., Boston, Mass.
Thompson, Sanford E. ....136 Federal St., Boston, Mass.
Webb, DeWitt C. ....426 State House, Boston, Mass.

DEATHS.

Jaques, William Henry ....November 23, 1916
Parker, Harold ....November 29, 1916

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

No. 378. Age 30. Has had International Correspondence School course in mechanical drawing, and is now taking correspondence course in mechanical drafting. Desires work as tracer.

No. 379. Age 35. Experience includes five years as rodman and transitman with Bay State St. Ry. Co.; seven years with Boston Elevated Ry. Co., as transitman, chief of party and inspector of concrete work on construction of Cambridge subway; two years with U. S. Government on survey of Merrimack River and other surveys; five months with Westinghouse, Church, Kerr & Co., as assistant engineer on construction of brick and concrete buildings. Desires position as transitman or draftsman. Salary desired, $80 per month.

No. 380. Age 28. Student at Y. M. C. A. evening school, and at Franklin Union. Experience includes work on Cambridge subway, B. & M. R. R., and with engineering firms. Desires position as rodman. Salary desired, $60 per month.

No. 381. Age 27. Student for three years at Rhode Island State College, mechanical engineering course; graduate of Tri-State Engineering College, civil engineering course. Has had experience as machinist and tool designer, inspector, instrumentman, engineer, draftsman and superintendent; experience includes concrete bridge building and highway construction. Desires position with contractor, as engineer, superintendent, foreman or estimator. Salary desired, $25 as estimator, or $35 per week as engineer, superintendent or foreman.

No. 382. Age 34. Student for three years at Mass. Inst. of Technology, class of 1903. Experience includes four and one-half years with Directors of Port of Boston, chiefly as resident engineer, So. Boston Dry Dock; five and one-half years with Boston Elevated Ry. Co., as assistant engineer; one year with U. S. Army, as civil engineer, on construction work; two years, as draftsman and inspector, with U. S. Navy, Dept. of Yards and Docks. Desires position on construction work, preferably heavy foundations or " water work." Salary desired, $125 per month.

No. 383. Age 27. Graduate of Mass. Inst. of Technology, 1912, civil engineering course. Has had experience as recorder and rodman, U. S. Engineer Office; rodman with B. & M. R. R. and with N. Y. C. R. R.; and as draftsman, timekeeper, foreman and structural iron worker on bridge erection and concrete construction. Desires position as estimator or foreman with contractor near Boston. Salary desired, $35 per week.

LIBRARY NOTES.

Recent Additions to the Library.

U. S. Government Reports.

Buying and Selling of Ores and Metallurgical Products. Charles H. Fulton.

Coal-Tar Products and Possibility of Increasing Their Manufacture in United States. Horace C. Porter.

Economic Surveys of County Highway Improvement. J. E. Pennybacker and M. O. Eldridge.

Some Engineering Problems of Panama Canal in Their Relation to Geology and Topography. Donald F. MacDonald.

Errors in Gas Analysis Due to Assuming that Molecular Volumes of All Gases are Alike. George A. Burrell and Frank M. Seibert.

Financial Statistics of Cities Having a Population of Over 30 000, 1915.

General Statistics of Cities, 1915; including Statistics of Governmental Organizations, Police Departments, Liquor Traffic, and Municipally Owned Water Supply Systems, in Cities Having a Population of Over 30 000.

Gold Log Mine, Talladega County, Alabama.

Lead in 1915. C. E. Siebenthal.

Mica in 1915. Waldemar T. Schaller.

Mining Developments and Water-Power Investigations in Southeastern Alaska. Theodore Chapin and George H. Canfield.

Notes on Prevention of Dust and Gas Explosions in Coal Mines. George S. Rice.

Notes on Some Mining Districts in Eastern Nevada. James M. Hill.

Oil and Gas Geology of Foraker Quadrangle, Osage County, Oklahoma. K. C. Heald.

Permissible Explosion-Proof Electric Motors for Mines; Conditions and Requirements for Test and Approval. H. H. Clark.

Platinum and Allied Metals in 1915. James M. Hill.

Primary Traverse in Illinois, Wisconsin, Minnesota, North Dakota, and South Dakota, 1913–1915. R. B. Marshall.

Primary Traverse in Louisiana and Mississippi, 1913–1915. R. B. Marshall.

Production of Explosives in United States during Calendar Year 1914. Albert H. Fay.

Progress Reports of Experiments in Dust Prevention and Road Preservation, 1915.

Specific-Gravity Separation Applied to Analysis of Mining Explosives. C. G. Storm and A. L. Hyde.

Spirit Leveling in Georgia, 1896 to 1914, inclusive. R. B. Marshall.

Spirit Leveling in New Mexico, 1902 to 1915, inclusive. R. B. Marshall.

Sulphur, Pyrite, and Sulphuric Acid in 1915. W. C. Phalen.

Tin Ore in Northern Lander County, Nevada. Adolph Knopf.

Vapor Pressure of Arsenic Trioxide. H. V. Welch and L. H. Duschak.

Water-Supply Paper 393.

State Reports.

Massachusetts. Annual Report of Homestead Commission for 1915.

New York. Annual Report of Public Service Commission for First District for 1914, Vols. 1 and 3.

Municipal Reports.

Andover, Mass. Annual Reports of Board of Public Works for 1912–15.

Auburn, N. Y. Annual Report of Water Board for 1915.

Boston, Mass. Contract for Constructing High-Pressure Fire Service Distribution System, 1913.

Burlington, Vt. Annual Report of Water Department for 1915.

Chelsea, Mass. Annual Report of Water Commissioner for 1915.

Dover, N. H. Annual Report of Water Commissioners for 1915.

New York, N. Y. Report of Department of Bridges for 1914 and 1915.

Miscellaneous.

Activated-Sludge Process in Treatment of Tannery Wastes. Harrison P. Eddy and Almon L. Fales. Gift of authors.

American Society for Testing Materials: Standards, 1916.

American Society of Mechanical Engineers: Transactions for 1915.

Bridge Engineering, 2 vols. J. A. L. Waddell.

Canada, Department of Mines: Investigation of Coals of Canada, Supplementary Report. J. B. Porter.

Clinton Wire Cloth Company: Clinton Handbook on Lath and Plaster; Successful Stucco Houses.

Contracts, Specifications and Engineering Relations. Daniel W. Mead.

Glasgow Iron Company: Catalogue for 1916.

Hydrated Lime Bureau: Ideal Mortar for Brick Masonry.

Typhoid Toll. George A. Johnson. Gift of author.

Last month a number of duplicate copies of magazines, reports, etc., were placed on the ends of the tables in the reading-room. These duplicates were listed in the JOURNAL and members were invited to help themselves. That this material was acceptable to many of our members is shown by the fact that most of it was taken within two weeks after the publication of the list, which fact has encouraged us to continue the work.

As last month, duplicates will be found *on the ends of the reading-room tables.* The list is as follows:

American Society for Testing Materials: Year-Book for 1914, containing Standard Specifications.

Institution of Civil Engineers (London): Vols. 195–198, Parts 1–4, 1913–14; Vol. 200, Part 2, 1914–15.

Massachusetts Gas and Electric Light Commissioners: Annual Report for 1908.

Mass. Inst. of Technology: Contributions from Sanitary Research Laboratory and Sewage Experiment Station, Vols. 2–6, 8.

Municipal Engineering: March, 1905–December, 1914; April–September, November, December, 1915; January–April, 1916.

New England Water Works Association: *Journal*, September, December, 1900; 1901–1904; March, June, December, 1905; 1906; March, June, December, 1907; 1908–1909; March, June, September, 1910; 1911–1913; March, June, December, 1914; March, June, December, 1915; March, September, 1916.

United States Census Bureau: Financial Statistics of Cities Having Population of Over 30 000, 1915.

United States Geological Survey: Bulletins 313, Granites of Maine, 1907; 376, Peat Deposits of Maine, 1909; 380, Contributions to Economic Geology, Part I, 1909; 491, Data of Geochemistry, 1911; Water-Supply Papers 3, 15, 20–25, 59, 65, 69, 79–84, 95, 96, 101–104, 110, 113, 114, 122, 143–145, 152, 189, 198, 201, 223, 226, 229, 238, 241, 255, 315.

United States War Dept.: Annual Reports of Chief of Engineers, 1900–1908, 1911–13, Parts 1 and 2, 1915. (1906–8, 1911–13, without appendices.)

A collection of manufacturer's catalogs known as "Catalog Studies" has been placed in the reading-room by the Catalog Equipment and Supply Company. These "Catalog Studies," to quote from the company's own statement, are "the assembled literature of manufacturers of technical merchandise, securely bound in books of convenient size, indexed and placed in a sectional oak filing cabinet."

"Catalog Studies" have been in use in the leading engineering schools of the country for some years, we understand. They are now being asked for by the engineering societies, and the company is installing a set in each of the ten largest cities in the country. We hope they may prove of value to our members.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before the 1st of each month.)

United States Government. — NAVY DEPARTMENT. — *Navy Yard, Boston.* — Work being done consists of:

Extension central power plant building to provide for air compressor plant, reconstruction of yard railroad track system, and concrete roadway at Naval Hospital, Chelsea.

Commonwealth of Massachusetts. — METROPOLITAN PARK COMMISSION. — The following work is in progress:

Charles River Reservation. — Building reinforced concrete bridge over the Charles River at North Beacon St., Boston and Watertown. A. G. Tomasello, contractor.

Building reinforced concrete bridge over the Charles River at Commonwealth Ave., Newton and Weston. T. Stuart & Son Company, contractor.

Mystic Valley Parkway. — Grading extension of Mystic Valley Parkway from Mystic St. to Medford St., Arlington. James H. Fannon, contractor.

Nantasket Beach Reservation. — Building concrete retaining and bulkhead walls southeasterly from roller-coaster. Hugh Nawn Contracting Company, contractor.

Old Colony Parkway.— Plans are being prepared for bridge over the Neponset River, Boston and Quincy, to replace old wooden bridge.

Boston Transit Commission. — The Dorchester Tunnel has been practically completed from its beginning at Tremont St. to a point under Dorchester Ave. near Broadway in South Boston.

Work is progressing on the Broadway station, which extends in Dorchester Ave. from Broadway to West Fourth St. The T. A. Gillespie Co. is the contractor.

Work on Section G, which extends in Dorchester Ave. from West Fourth St. to Old Colony Ave., is in progress. Coleman Brothers are the contractors.

Section H and Section H Extension, which are completed, extend in Dorchester Ave. from Old Colony Ave. to near Dexter St.

The next section, Section J, extending from a point near Dexter St. in a southerly direction in and near Dorchester Ave. and Boston St. to near Ralston St., and embracing the station in Andrew Sq., is being constructed. The T. A. Gillespie Co. is the contractor.

The relaying of the granite block paving, with grout joints and on a concrete base, in Dorchester Ave. from Old Colony Ave. to Humboldt Place, near Andrew Sq., is in progress. The T. A. Gillespie Co. is the contractor.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

Gaffney St.,	from Commonwealth Ave. to B. & A. R. R.	Asphalt.
Augustus Ave.,	from Metropolitan Ave. to Ethel St.	Bituminous macadam.
Washington St.,	from Morton St. to Asticou Rd.	Granite block.
Bardwell St.,	from South St. to Ballard St.	Asphalt.
Hillcrest St.,	from Elgin St. to Temple St.	Asphalt.
Lorette St.,	from Centre St. to Hillcrest St.	Asphalt.
Temple St.,	from Ivory St. to Spring St.	Asphalt.
Dunster Rd.,	from Centre St. to Pond St.	Asphalt.

Vista St.,	from Augustus Ave. to Malvern St.	Bituminous macadam.
Granada Ave.,	from Metropolitan Ave. to Ethel St.	Asphalt.
Cedric St.,	from Magazine St. to Langdon St.	Asphalt.
Homestead St.,	from Humboldt Ave. to Elm Hill Ave.	Asphalt.
Amory St.,	from Centre St. to Bragdon St.	Granite block.
Dearborn St.,	from Albany St. to Dudley St.	Asphalt.
Dorchester Ave.,	from Savin Hill Ave. to Freeport St.	Granite block.
Hill Top St.,	from Granite Ave. to Hallet St.	Bituminous macadam.
Columbia Rd.,	from Edward Everett Sq. to Dudley St.	Granite block.
Everton St.,	from Geneva Ave. to Olney St.	Asphalt.
Alexander St.,	from Bird St. 527 ft. northerly.	Granite block.
Eric Ave.,	from Savin Hill Ave. northerly.	Asphalt.
Lithgow St.,	from Talbot Ave. to Wainwright St.	Asphalt.
Harwood St.,	from Willowwood St. to Lucerne St.	Asphalt.
Upland Ave.,	from Park St. to Melville Ave.	Asphalt.
Orchardfield St.,	from Dorchester Ave. to Freeport St.	Asphalt.
Centervale Pk.,	from Upland Ave. to Bourneside St.	Asphalt.
Epping St.,	from Washington St. to Norfolk St.	Asphalt.
Westwood St.,	from Richfield St. to Wales Pl.	Asphalt.
Theodore St.,	from Morton St. to 618 ft. northerly.	Asphalt.
Morton St.,	from Norfolk St. to N. Y., N. H. & H. R. R.	Artificial stone walks.
Albany St.,	from Dover St. to Northampton St.	Granite block.
School St.,	from Washington St. to Tremont St.	Granite block.
Devonshire St.,	from Adams Sq. to Water St.	Wood block.
No. Anderson St.,	from Parkman St. to Fruit St.	Asphalt.
Parkman St.,	from No. Anderson St. to No. Grove St.	Asphalt.
Canal St.,	from Haymarket Sq. to Causeway St.	Granite block.
Ripley Rd.,	from Vassar St. to Harvard St.	Asphalt.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

Thirteen submarines for U. S. Navy.
Eight torpedo boat destroyers for U. S. Navy.
Five vessels for the Luckenbach Co.
Two vessels for the Texas Co.
One vessel for the Argentine Government.
One vessel for the Cuba Distilling Co.
Two vessels for the Mexican Petroleum Co.
Two stock steamers.

Vol. III DECEMBER, 1916 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

THE PORTLAND BRIDGE.

BY EUGENE E. PETTEE, MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS.

(Presented September 20, 1916.)

HISTORY.

THE first bridge at the site of the structure described in this paper was a toll bridge built by a company about 1828. It was a pile bridge, 25 ft. wide and about 4 ft. above high water, extending from what was then Cape Elizabeth to within about 200 ft. of Commercial Street, and had a leaf draw at about the location of the present draw. From this last point it ascended on a grade of about 9.2 per cent. to a point about 50 ft. beyond Commercial Street, and from that point to York Street the grade was 12 per cent. The old Portland, Saco & Portsmouth Railroad, now the eastern division of the Boston & Maine Railroad, passed under the bridge about 10 ft. south of Commercial Street.

The Bridge Company was bought out by the town of Cape Elizabeth, and the right of way was transferred to the county of Cumberland. Under a petition from the citizens of Cape Elizabeth and the city of Portland, the grade of the bridge was dropped to the level of Commercial Street, and the upper part abandoned. In subsequent years, the railroad companies es-

---

NOTE. Discussion of this paper is invited, to be received by the editor before February 10, 1917, for publication in a subsequent number of the JOURNAL.

tablished a freight terminal east of the bridge site, and put in, without authority from anybody, twenty-four additional tracks (Fig. 2), and created what subsequently became known as the "Gridiron of Death," and were indicted as a nuisance. To stave off the results of the indictment, by an agreement under the preamble of motive "to establish safety of travel," the Railroad Company built the Clark Street Bridge (Fig. 1) and laid out a line of additional travel by the head of their wharf into State Street, to be crossed by only one track, serving intermittently the Steamboat Wharf. In 1908 it built the coal elevators on the east side of the old bridge right-of-way (Fig. 2), and the Railroad Commission gave it the right to lay a track to them, which, in operating, resulted in about one hundred and fifty crossings in ten hours over the agreed-upon safety line of travel.*

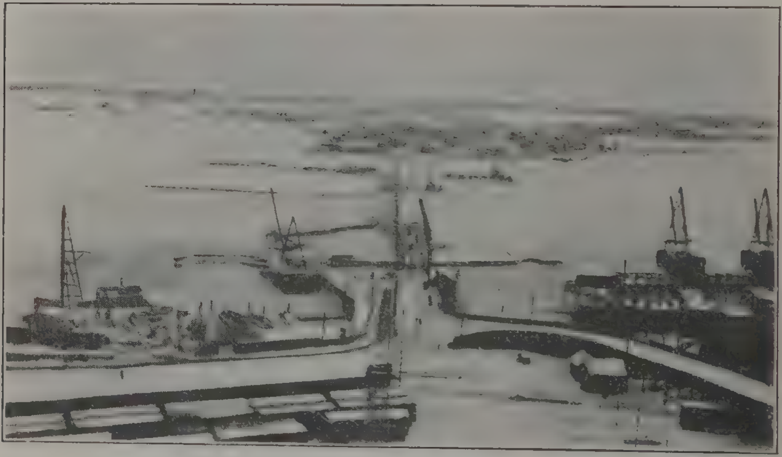


FIG. 1. OLD BRIDGE AND TEMPORARY STRUCTURE.

The original bridge had been repaired and rebuilt from time to time, and when work began on the new structure the old bridge (Plate II) consisted of a pile trestle with floor at elevation 17.00 above mean low water, and a steel truss swing draw, with two 70-ft. openings. The roadway of the bridge varied in width from 26 ft. to 32 ft., and there was but one sidewalk. The tracks of the Street Railway Company were carried on its own trestle directly east of the bridge, except at the draw, where the track swung in on to the roadway. As the draw had a roadway only 20 ft. wide, and as all traffic had to pass through this narrow throat, traffic frequently became congested. This congestion was very bad when the draw had to be opened, and caused much delay and annoyance. The bridge was in constant need of repair, particularly the draw, which was badly corroded beneath the floor. Many people were timid about using the bridge, and there was a strong demand for a new one, which finally resulted, in 1913, in the passage by the legislature of a bill authorizing the Cumberland County Commissioners to build a new bridge, provided the Portland Terminal Company, the successors of the Portland, Saco & Portsmouth Railroad, would agree to pay 40 per cent. and the Portland Railroad Company (operating the street railway) would pay 10 per cent. and that the bridge should not cost more than one million dollars. This consent of the corporation was obtained, and the County Commissioners appointed J. R. Worcester & Co.,

---

* This data furnished by E. C. Jordan, M. Am. Soc. C. E., Portland, Me.

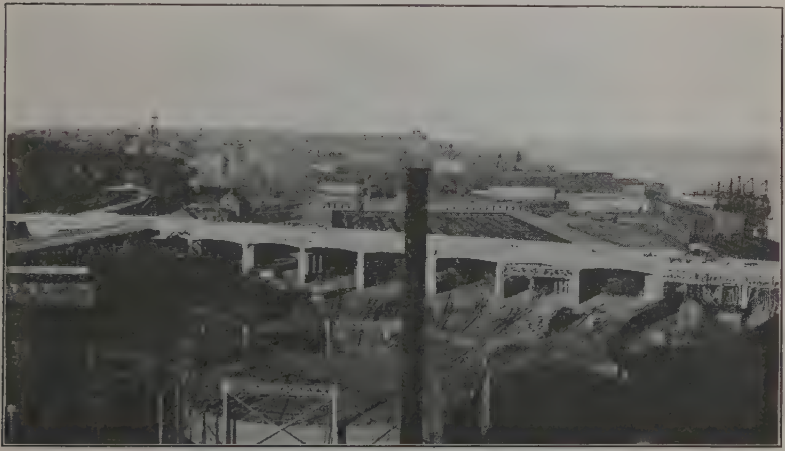


FIG. 2. SECTIONS 4, 5 AND 6.

engineers, to make plans and take charge of erection of the bridge. A survey of the site was begun on March 1, 1914, and contracts were signed November 16, 1914. The new bridge was opened to traffic July 20, 1916 (Fig. 9).

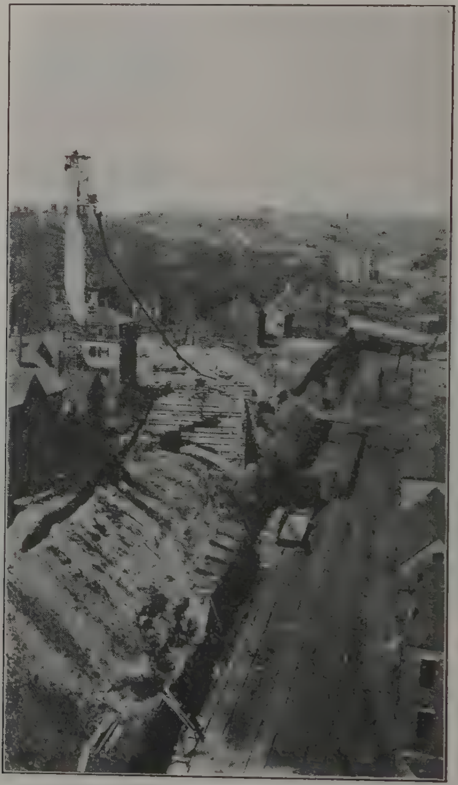


FIG. 3. CONSTRUCTING SECTION 6,
TYNG STREET TOWER AT LEFT.

GENERAL DESCRIPTION.

The roadway of the new bridge starts at the street level in South Portland and runs on a slight grade to the high level of the streets just beyond the water front in Portland. This gives a rise of about 40 ft. and a length of about 3 000 ft., providing ample clearance over the railroad tracks on the Portland waterfront and 30 ft. of headroom under the draw at high water (Plate I). A large part of the city of Portland is built on high ground, and most of the traffic comes to the bridge at this high level. By bringing the bridge to this level, heavy grades were avoided and a more direct route provided.

In plan, the lines of the bridge coincide with the street lines in South Portland, from which point the new lines diverge from the old by a small angle, so that in a distance of about 700 ft. the easterly line of the new bridge coincides with the westerly line of the old bridge. From this point the new bridge continues parallel to the old bridge and runs straight across the harbor, the many tracks of the Portland Terminal Company, and Commercial Street, to the foot of Brackett Street at the edge of the upper level of the city. From Brackett Street the main approach swings to the east over a steep bank to the junction of State and York streets (Fig. 3). The street railway and most of the heavy teaming comes along York Street, while most of the automobile and foot traffic comes down State Street.

FIG. 4. SECTIONS 1 AND 2.

Besides the main approach at State Street, there is an entrance at Brackett Street by a rather steep grade (10.7 per

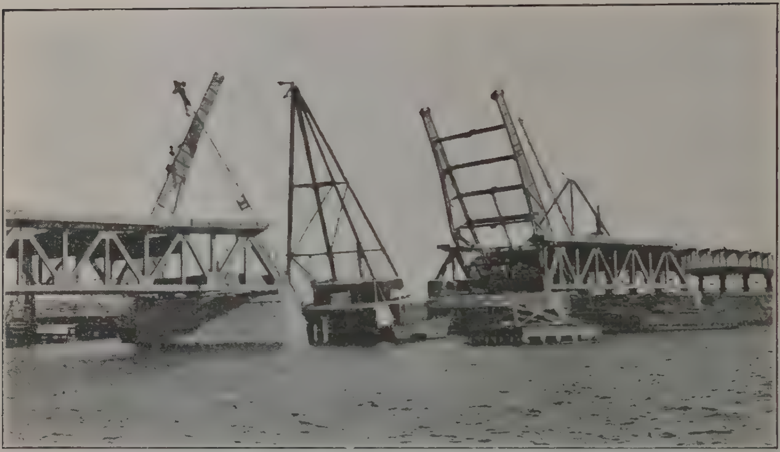


FIG. 5. ERECTING DRAW SPAN.

cent.). There is also a third approach from the west at the junction of York and Clark streets. The total length of the bridge, including approaches, is 4 000 ft.

DETAILS OF CONSTRUCTION.

The bridge is divided into six sections of different types of construction.

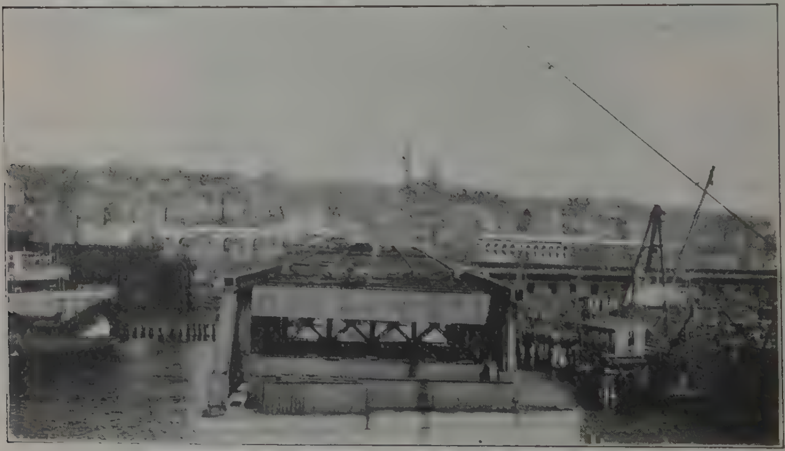


FIG. 6. LOOKING NORTH ON SECTION 3.

Section 1.

Section 1 begins at A Street in South Portland, and is 860 ft. long. It consists of about 60 000 cu. yds. of sand and clay fill with grassed slopes and protected by riprap to elevation 14.0, datum being mean low water. (Fig. 4).

FIG. 7. VIEW FROM BRACKETT STEEET SHOWING PIERS AND TEMPORARY BRIDGE.

Section 2.

Section 2 is 306 ft. long and consists of 12 spans of 25 ft. each, of reinforced concrete beam construction, having the appearance of segmental arches. It is carried on pile foundations protected by filling and riprap, the ground below consisting of mud flats covered by tide at high water. (Fig. 4 and Plate III.)

Section 3.

Section 3 is 1 008 ft. long and consists of nine spans of 98 ft. each and a draw span having a clear opening of 100 ft. Seven of these spans have steel girders of cantilever construction with a 3-ft. rise of the bottom flange, giving the appearance of flat arches. The two spans adjoining the draw are steel trusses with horizontal chords. These two spans, with the draw span, have a level roadway. The draw span is a double-leaf Scherzer Rolling Lift Bridge. (Figs. 5 and 6, and Plates I and V.)

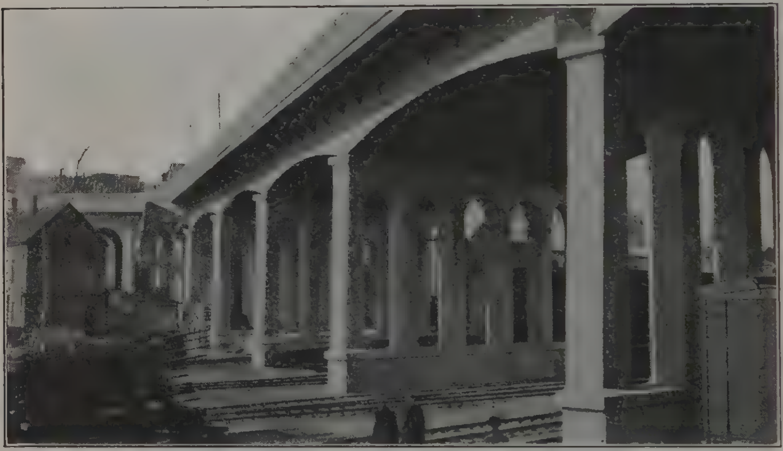


FIG. 8. SECTION 4.

Section 4.

Section 4 consists of 13 spans of lengths varying from 30 ft. to 67 ft., of reinforced concrete cantilever-beam construction, the bottom of the beams being crowned to give an appearance similar to the steel spans of Section 3. (Figs. 7, 8, 9, Plates VI and VII.) Section 4 has a total length of 758 ft. Sections 1, 2, 3 and 4 comprise the straight portion of the bridge and have a total length of 2 932 ft. (Plate I.)

Section 5.

Section 5 is known as the Clark Street Viaduct, and has 14 spans of 16.47 ft. each, and ends in a solid fill held by reinforced

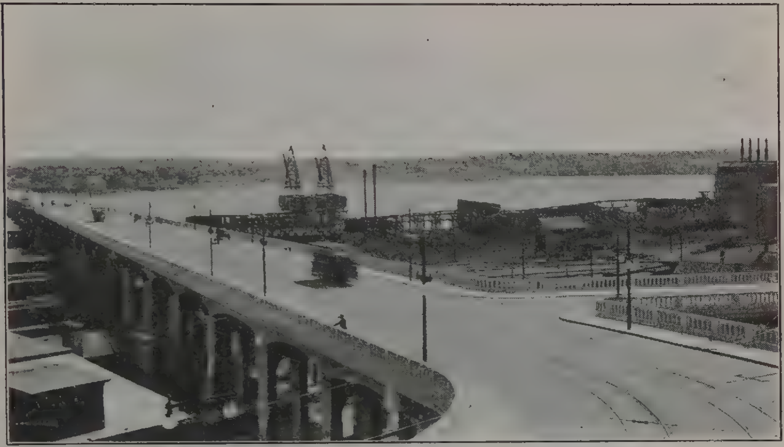


FIG. 9. SECTION 4.

concrete retaining walls. The total length of this section is 333 ft. (Fig. 10.) The floor of this section consists of flat slabs carried by cross floor beams, which are supported by three lines of columns. The columns are placed under the curbs and under the center line of the roadway, and are braced longitudinally with beams having semicircular soffits, as have also the

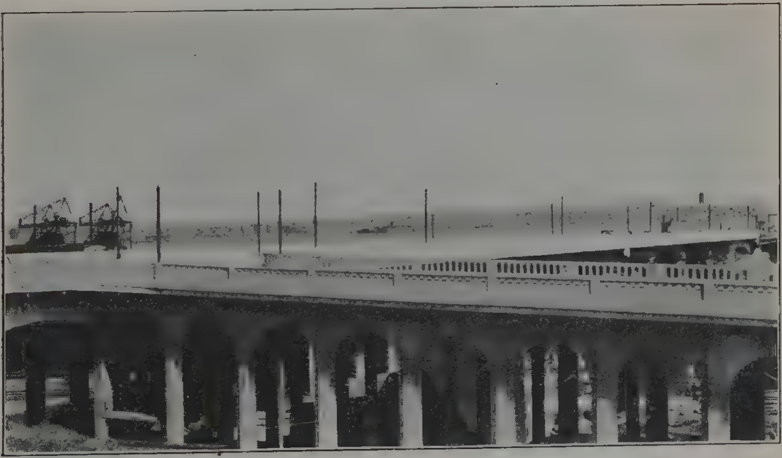


FIG. 10. SECTION 5. SECTION 4 IN BACKGROUND.

floor beams. The sidewalks are carried on curved brackets cantilevered from the floor beams. The tops of the columns, being connected together with semicircular arches in both directions, give a very pleasing effect from below. (Fig. 11, and Plate IX.)

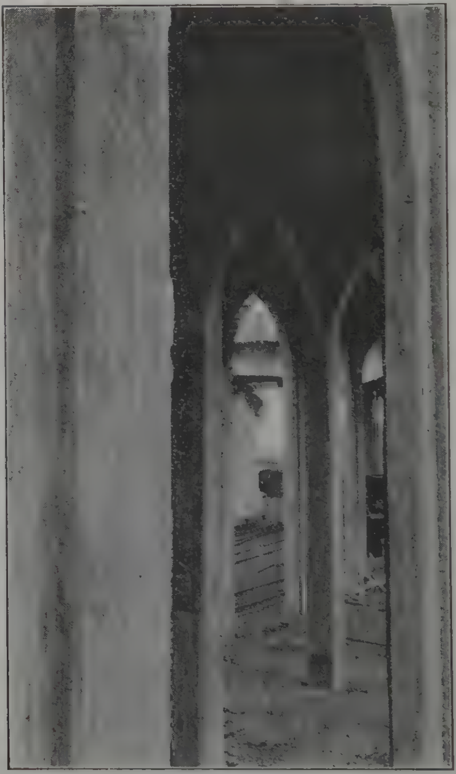


FIG. 11. SOFFITS OF SECTION 5.

Section 6.

Section 6 is known as the State Street Viaduct, and has forty spans of 12.5 ft. each and ends in a solid fill held by concrete retaining walls. It has a total length of 735 ft. This section is built on a steep hillside above a railroad cut. The roadway of the bridge is 44 ft. above the railroad on one side and cuts

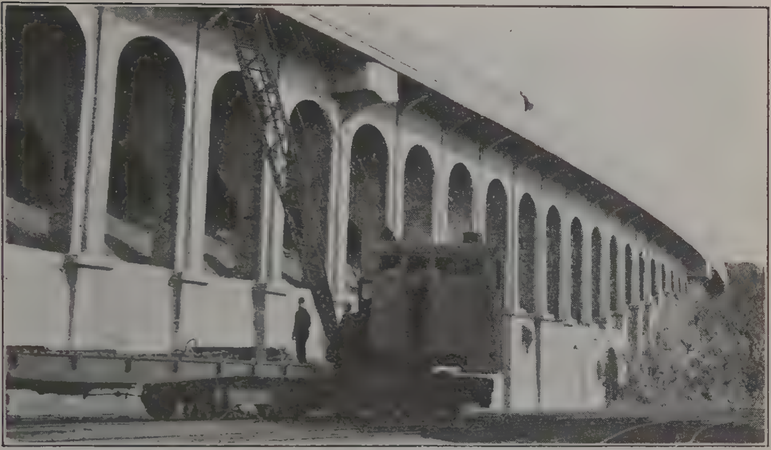


FIG. 12. SECTION 6.

into the bank on the other side. (Figs. 3, 12 and 13 and Plate X.)

CONTRACTS.

The construction of the bridge was divided into three contracts, A, B and C.

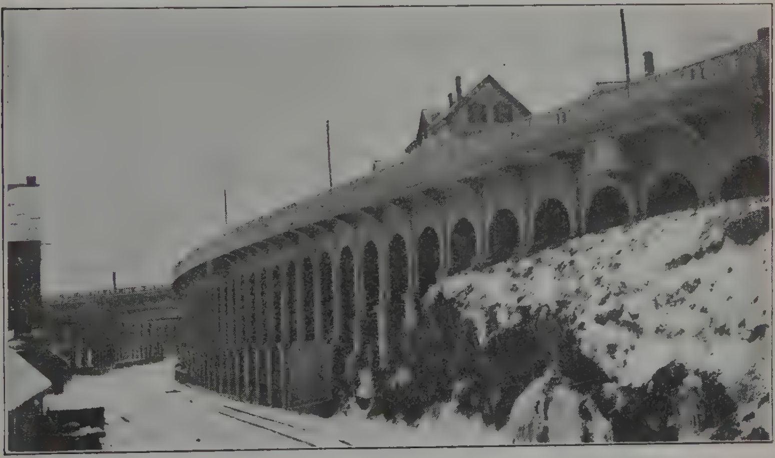


FIG. 13. SECTION 6, LOOKING TOWARDS SECTION 4.

Contract A.

Contract A included the fill of Section 1, the foundations of Section 2, the piers of Section 3, the foundations of Section 4 as far as Commercial Street (which was as far as it was necessary to use piles), and the temporary bridge. (Fig. 7.) It was awarded to Holbrook, Cabot & Rollins Corporation.

Contract B.

Contract B included the structural steel spans of Section 3 across the harbor, and the Scherzer Rolling Lift Draw. (Figs. 5 and 6, and Plate V.) It was awarded to the Phœnix Bridge Company.

Contract C.

Contract C included: in Section 1, the granite block paving on a concrete base, granolithic sidewalks with concrete retaining walls, the reinforced concrete fence and the loaming and seeding of the slopes of the fill; in Section 2, everything above the foundations; in Section 3, the floor slabs, granolithic sidewalks, concrete fence and wood block paving of the roadway; all of Section 4 with the exception of the foundations mentioned before under Contract A; and the whole of Sections 5 and 6. It was awarded to T. Stuart & Son Co.

TEMPORARY BRIDGE.

The street railway company's trestle, just east of the old bridge, was largely utilized for a temporary bridge, but opposite the old draw a new trestle was carried out at an angle far enough to allow the temporary draw to swing clear of the old bridge. (Fig. 1.) The trestle had to be widened and planked, and a sidewalk was also provided.

Construction of Temporary Bridge.

The greater part of the construction of the temporary bridge was sublet by Holbrook, Cabot & Rollins Corporation to the Bennett Contracting Corporation of Portland, which began driving piles December 7, 1914. The work proceeded rapidly and was completed as far as was possible, without interrupting traffic, on March 12, 1915. The new draw of the temporary bridge had already been shipped by the Boston Bridge Works, and the center portion, together with the part across one channel, had been erected in place. The opposite end had been assembled on a lighter and riveted as far as possible, and, at six o'clock in the morning of March 12, this lighter, with the remaining portion of the draw, was floated into position and the erection completed, thus closing the channel to navigation. All traffic, including the street cars, was maintained over the old bridge until noon, when traffic was interrupted with the exception of pedestrians, and the work of cutting the old drawbridge in two begun. This cutting was done by means of blaw gas, and was completed in an hour and fifty minutes. The portion of the old draw cut off was supported on lighters, and the work of stripping the old draw of rails and woodwork was started. Meantime, the laying of rails and planking on the new bridge was proceeding. At 7.15 P.M. the temporary bridge was ready for use, and the portion of the old draw which had been cut off was floated away. (Fig. 14.) Thus team and electric car traffic was interrupted from noon until 7.15 P.M.,

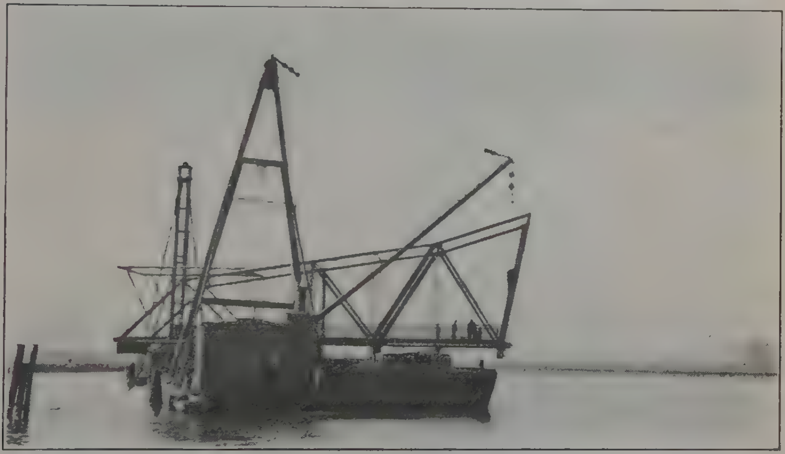


FIG. 14. OLD DRAW SPAN ON LIGHTER.

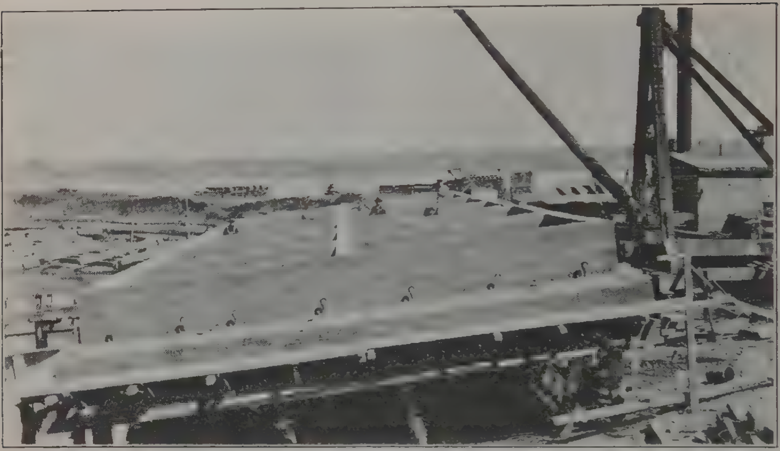


FIG. 15. CAISSON ON LAUNCHING WAYS.

while foot traffic was kept up all day, either across the old bridge or on the new temporary bridge.

HARBOR PIERS.

The method adopted by the Holbrook, Cabot & Rollins Corporation for building the harbor piers, which occurred in

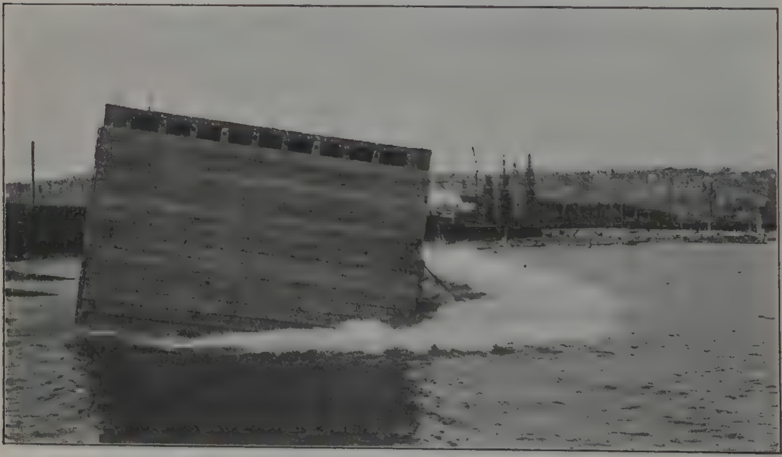


FIG. 16. LAUNCHING CAISSON.

deep water, was interesting and proved very successful. A site was selected just east of the bridge in an enclosed position where a launching-way was built consisting of a platform resting on piles and sloping towards the water. On this platform a bed of three-inch lagging was laid, corresponding in shape to the bottom of the pier. On this lagging forms were built and a reinforced concrete box constructed, about 4½ ft. deep, having a projecting flange all around the outside, through which projected hook bolts. (Fig. 15.) On this flange wooden sides of 12 by 12 hard-pine posts with 4-in. hard-pine planking on the

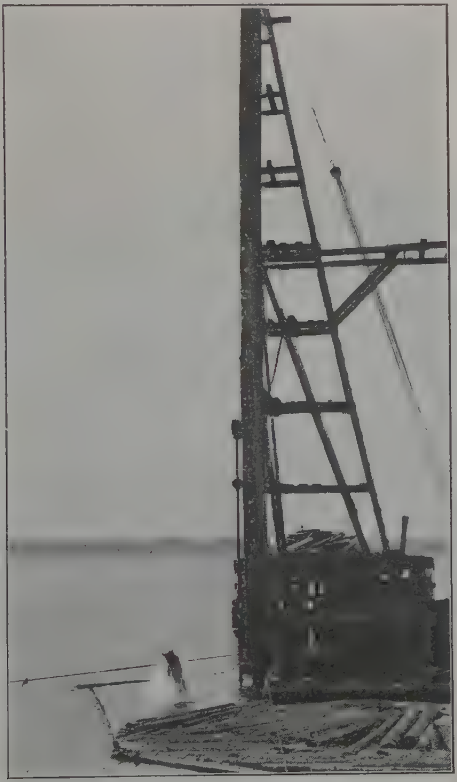


FIG. 17. CUTTING PILES FOR HARBOR PIERS.

outside were built up about 18 ft. high. The top timbers were connected by means of rods with the hook bolts anchored in the concrete, and tightly screwed up. The whole structure was then carefully calked and finally launched. (Fig. 16.) This great box or caisson floated high out of water and was towed alongside of a large lighter equipped with a concrete plant and was gradually filled with concrete. On this concrete as a bed, forms of the proper size for the pier were erected within the caisson, and filled with concrete. As the load increased, and the caisson gradually sank, the sides were twice extended until the total depth reached about 54 ft.

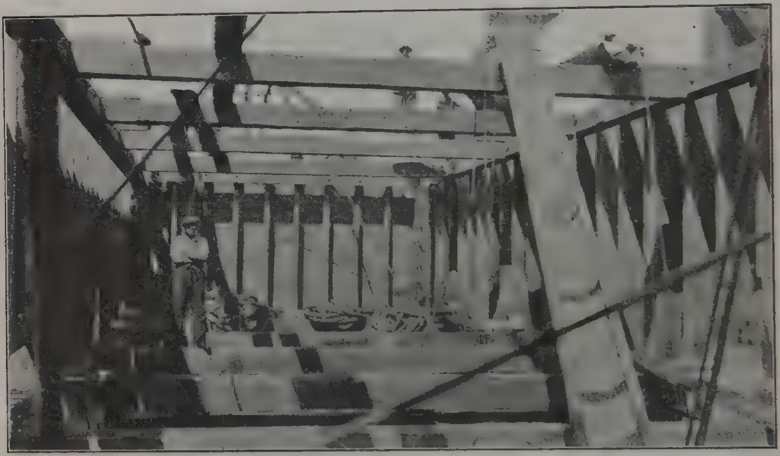


Fig. 18. Sinking Caisson, Water being Admitted.

The caisson was then towed to its site which had already been prepared by considerable dredging and by driving piles over the whole area. These piles were cut off quickly by a large circular saw on a vertical shaft carried in the gins of a large pile driver. (Fig. 17.) By means of a level placed on shore, sighting on a white band painted on the vertical shaft carrying the saw, the piles were cut off accurately to grade. The caisson was then filled, until it touched bottom at low tide, when it was very exactly located by means of two transits set up on shore at right angles to each other, and sighting on the two center lines of the caisson. Water was then let into the space between the sides of the caisson and the concrete pier (Fig. 18) until the caisson became so heavy that it would not float again at high water.

Then came the work of building up the concrete to elevation −2, where the granite facing began. This facing was carried up well above high water, the concrete core being carried up simultaneously (Plate IV). The rods connected with the hook bolts at the bottom of the caisson were then loosened and the connections unhooked, allowing the sides to float up to the surface. They were then towed away and used on another caisson. This method permitted all concrete work to be cast dry, and also permitted thorough inspection.

Reinforced Concrete Construction.

Practically all of the reinforced concrete construction in the bridge was done by T. Stuart & Son Company, of Newton. They began unloading their equipment November 30, and put in a very complete plant consisting of a mill containing electrically driven saws and planes, a large platform adjoining the mill for building forms, and two towers for hoisting concrete to be delivered by chutes to all parts of Sections 4, 5 and 6. The tallest tower was placed directly east of the bridge and near Commercial Street, and was provided with a runway up which teams drew all the materials, which were dumped through traps in the floor of the platform, where they could run by gravity to the mixer at the foot of the tower. The mixer dumped directly into an elevator bucket which could be rapidly raised to a hopper near the top of the tower. This hopper had a valve controlled by one man who allowed the concrete to flow into the chutes as desired. This tower was 155 ft. high and was built of light steel sections. Another similar tower, 105 ft. high, was erected at the foot of Tyng Street (Fig. 3), which is about midway between the main bridge and the end of Section 6. These towers could deliver concrete to all parts of the work except at the ends of Sections 4 and 5, where it was necessary to carry it in buggies. Stuart's contract called for an immense amount of difficult form work, and he used about one million two hundred and fifty thousand feet, board measure, of lumber. Much of this lumber was used over and over again, some of it as many as a dozen times, being always carefully cleaned and oiled.

Sand and Stone.

All sand and stone for concrete was brought from a gravel pit in South Portland, about a mile from the bridge. This material was all carefully washed at the pit by means of an elaborate mechanical system. The sand was of an unusually good quality, testing well over 100 per cent. of the strength of standard sand, and the stone was well graded in size.

Cement.

The cement used under Contract C was Allentown, and each carload was tested. No carload failed in the tests. This was also true of the Catskill Alpha used in Contract A.

Piles.

The piles used for the temporary bridge varied in length from 30 to 80 ft. and were of white pine, yellow pine and spruce. In driving the piles for the center draw pier and draw landings of the temporary bridge it was found necessary to use piles longer than any of those on hand, and the contractor succeeded in getting a lot of white pine piles in Maine, which ran from 70 to 80 ft. in length. The piles for Section 3 varied from 25 to 50 ft. in length after cutting and were practically all hard pine, except for the permanent fender piers, where oak piles were used. The piles for Section 4 varied in length from 15 ft. to 55 ft. and were of hard pine. Piles for the temporary bridge were driven by a drop hammer, while all of those for Sections 3 and 4 were driven by a large steam hammer. All piles were driven to a very hard stratum and had a penetration of about one inch under the drop hammer and of less than $\frac{1}{8}$ in. under the steam hammer for the last few blows. The supporting power of the piles is apparently excellent, as no measurable settlement has occurred.

RIPRAP.

The slopes of Section 1 and the foundations of Sections 2 and 3 were protected with riprap (Fig. 4). The riprap for Section 3 varied in size from one-man stone to several tons. The riprap for the slopes of Section 1 consisted of large flat slabs carefully laid to a smooth surface, and the bottom was protected by a toe of riprap about 5 ft. high and 5 ft. wide. There was considerable trouble with this riprap, as the material of the fill upon which it was laid was very fine and was washed out badly by the waves whenever the wind was in the west. It was found necessary to cover up this flat slab riprap with riprap varying in size from small stones up to one-man size. This was piled on top to a depth of about two feet, and has overcome the difficulty.

EXPANSION JOINTS.

Expansion and contraction was carefully provided for throughout the bridge. There are also deflection joints at the ends of the cantilevers.

In Section 2 the expansion joints occur every third span, or 75 ft. apart, and were made by means of a double pier with a break in the center.

In Section 3 the expansion joints occur at the ends of the cantilevers where the link spans are supported, and are 130 ft. 4 ins. apart for a maximum.

In Section 4 the expansion joints are similar to those in Section 3 with a maximum distance apart of 91 ft. 6 ins. This structure being all reinforced concrete, an expansion and deflection joint having three seats was designed and has been proved to work successfully. (Plate VIII.)

In Section 5 the expansion joints occur at the center of every third span, or 49 ft. 5 ins. apart. (Plate IX.)

In Section 6 the expansion joints occur at the center of every other pier, or 25 ft. apart.

All these expansion joints are carried completely through the structure with the exception of the paving in Sections 4, 5 and 6. Here the joints were near together and the amount of motion so small that the paving was simply laid and filled with pitch for a short distance at the joints. The expansion joints in the paving in Sections 2 and 3 are made by means of heavy angle irons built up in the form of Z's, forming a stop against which the paving was laid and covering the opening with a sliding joint.

The expansion joints in the sidewalks were made with cast-iron plates with checkered tops and sliding one upon the other, the plates being anchored into the sidewalk slabs.

FENCE.

All fence for the bridge was made of reinforced concrete 3 ft. 6 ins. high and 7 ins. thick. The fence has openings 9 ins. wide by 22 ins. deep, with semicircular top and with spaces between the openings varying between 6 ins. and 8 ins. The fence was made in panels varying in length from 3 ft. 6 ins. to 10 ft. 3 ins. These panels were cast in sand molds by Simpson Brothers, of Boston, and were shipped to the site by rail. The sidewalk brackets were made in a similar way, also by Simpson Brothers.

PAVING.

The paving at the ends of the bridge where it was laid upon filling consisted of granite blocks. The fill in all cases had plenty of time to become thoroughly settled, and it was further compacted by means of a steam roller. Upon this sub-grade a 6-in. slab of concrete was laid, and then the granite paving with gravel joints was laid on a sand cushion. The whole surface was then thoroughly grouted. The paving over all the rest of the bridge consisted of Jennison-Wright wooden lug blocks, 3½ ins. deep. The surface of the concrete slab upon which the paving was to be laid was covered with a mixture of cement and sand in the proportion of one to four, mixed dry. This was very carefully leveled by means of screed templates, giving a depth of about ½ in. The cushion was then sprinkled with water, the blocks immediately laid and the joints filled with fine, clean sand by sweeping. The whole surface was then thoroughly wet with a hose and carefully brought to a true surface by means of tamping. The sand was allowed to remain upon the paving to a depth of about ½ in. and became thoroughly worked into the joints by traffic. The paving has now been in service for three months and has given practically no trouble and presents a very smooth surface.

Scuppers.

Cast-iron scuppers were placed along the curb at frequent intervals, and under extremely heavy rains have proved entirely adequate to carry off the water.

Conduits.

There are a great many lines of wires carried across the bridge, both for telephone and electric light and power. These wires are carried in conduits laid between the double slabs of the sidewalks, manholes being provided at proper intervals to enable the wires to be pulled through. At the draw opening, these wires are carried down in cables through a trench dredged in the bottom of the channel.

Drawbridge.

The drawbridge is a Scherzer Rolling Lift Draw having two leaves, each approximately 85 ft. long by 60 ft. wide. The counterweights are carried by cross members between the lower ends of the draw trusses, and are well above high water when the draw is opened. These counterweights are made of reinforced concrete, having a large pocket in each. By means of small loose blocks of concrete placed in the pockets, the draw leaves can be correctly balanced under any condition. The draw is operated by electricity and has self-locking jaws. Provision is also made for hand operation in case the electrical equipment should get out of order. In the operating house are small signal lights which show the exact location of the leaves when operated at night. The draw can be opened in a little less than a minute.

LIGHTS.

The bridge is lighted by double lights, supported by ornamental brackets on each trolley pole; the poles being spaced about 100 ft. apart.

PERSONNEL.

The bridge was designed by J. R. Worcester & Co., and was erected under their personal supervision, with the writer as resident engineer.

The bridge was built under the charge of the Cumberland County Commissioners, James Carroll Mead, chairman, James H. McDonald and W. F. Pillsbury. Mr. Mead died soon after the contracts were signed, and Mr. McDonald became chairman, the third place on the board being filled by Mr. Charles A. Maxwell.

Contract A was in charge of Mr. L. S. White, superintendent for Holbrook, Cabot & Rollins Corporation; Contract B was in charge of Mr. James Bason, superintendent for the Phœnix Bridge Company; while Contract C was in charge of Mr. Albert T. Stuart, of T. Stuart & Son Co. These three superintendents were all remarkably able men, and conducted the work with great speed and very fine results. Mr. McDonald, chairman of the Commission, took great interest in the work and usually visited the site twice a day.

* * *

UNIT PRICES.

Sand fill	$0.60	cu. yd.
Cinder fill	.50	,, ,,
Excavation, Contract C	1.45	,, ,,
,, of sea wall	2.00	,, ,,
,, Contract A	1.00	,, ,,
Dredging	.50	,, ,,
Back fill, Contract C	.20	,, ,,
Riprap, Contract A	2.50 to $3.50	per ton
Concrete cast in water	6.50	cu. yd.
,, backing	5.50	,, ,,
,, foundations, Section 4	7.00	,, ,,
Reinforced concrete	8.37	,, ,,
,, ,, extra	15.00	,, ,,

Rods for reinforcement	$0.024 to .05 per lb.
Wire mesh ,,	.035 per lb.
Removing old granite paving	.30 sq. yd.
Granite paving on gravel	2.25 ,, ,,
,, ,, on 6 in. concrete base	3.25 ,, ,,
Granolithic sidewalk on fill	1.65 ,, ,,
Granite curb	.50 per ft.
,, ,, extra	1.25 ,, ,,
,, ,, curved, extra	1.50 ,, ,,
Lug block paving	1.65 sq. yd.
Metal curb bar	.10 per ft.
Pipe fence	.75 ,, ,,
Reinforced concrete fence	1.45 ,, ,,
,, ,, ,, extra	2.50 ,, ,,
Loricated 1-in. pipe	.035 ,, ,,
Fiber conduct	.04 ,, ,,
Castings	.02 per lb.
Trolley base castings	.035 ,, ,,
Gravel sidewalk	.60 sq. yd.
Paved gutter	.20 lin. ft.
Catch basins in fill	67.00 each
Granite facing piers	21.00 cu. yd.
Granolithic finish	.045 sq. ft.

Note: Prices for reinforced concrete do not include forms or equipment.

* * *

COST OF SPRUCE OR HARD PINE PILES DRIVEN AND CUT.

Section 3.

25 ft. long	$5.00 each	
25 to 30 ft. long	5.50 ,,	Driven from floating machine with follower, and cut below water.
30 ,, 35 ,, ,,	6.85 ,,	
35 ,, 40 ,, ,,	7.75 ,,	
40 ,, 45 ,, ,,	9.00 ,,	
45 ,, 50 ,, ,,	11.25 ,,	
50 ,, 55 ,, ,,	12.00 ,,	

Sections 2 and 4.

15 ft. long	$4.50 each	
15 to 20 ft. long	4.75 ,,	
20 ,, 25 ,, ,,	5.15 ,,	
25 ,, 30 ,, ,,	5.60 ,,	Driven with land driver and cut above ground.
30 ,, 35 ,, ,,	6.00 ,,	
35 ,, 40 ,, ,,	8.00 ,,	
40 ,, 45 ,, ,,	9.00 ,,	
45 ,, 50 ,, ,,	11.00 ,,	
50 ,, 55 ,, ,,	12.00 ,,	
55 ,, 60 ,, ,,	14.00 ,,	

Finishing concrete surface	$0.01 sq. ft.
Temporary bridge	$30 000.00

STRUCTURAL STEEL.

Girder spans erected	$0.0313 per lb.
Truss ,, ,,	.0328 ,, ,,
Draw span erected	.0473 ,, ,,
Erection of steel work (bolted)	.0068 ,, ,,
Riveting	.0010 ,, ,,

UNIT STRESSES.

Concrete construction was designed in accordance with the recommendations of the Joint Committee.

Structural steel work was designed in accordance with the specifications of the American Railway Engineer's Association.

Cost of bridge	$965 000
Land damages	76 000
Cost, less land damages	$889 000

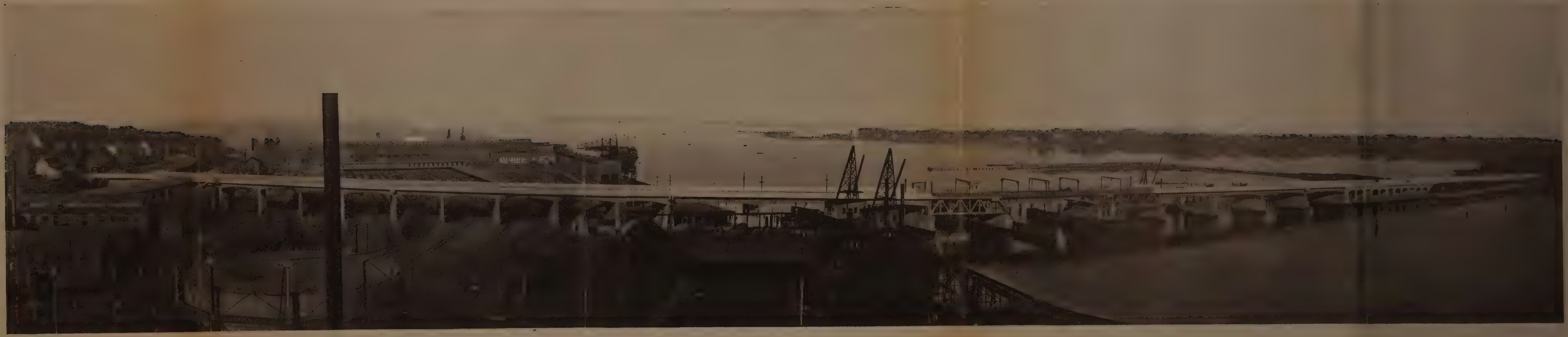


PLATE I.
JOURNAL BOSTON SOCIETY OF
CIVIL ENGINEERS.
DECEMBER, 1916.
PETTEE ON
PORTLAND BRIDGE.

PANORAMA OF
COMPLETED STRUCTURE.

INDEX.

VOLUME III, 1916.

ABBREVIATIONS. — D. = Discussion; I. = Illustrated.
Names of authors are printed in *italics*.

PAGE

Ackerman, A. S. Determining Weight of Stone in Vessels......May, 203 — ?
~~*Adams, E. P.* Discussion of Pan-American Use~~ of the Metric System. Sept., ~~399~~
~~Address at the Annual Meeting. *Charles R. Gow*..............Apr., 125~~
~~*Andrews, H. B.* Discussion of Special Methods of Reinforced Concrete~~ Design...~~Jan., 30~~
Arch, Groined, as a Means of Floor Construction. *H. Whittemore Brown*..I., Oct., 439 Flo
Atwood, Thomas C. The Yale Bowl......................I., June, 231 — ?

Barrows, H. K. Discussion of Power Estimates from Stream Flow ~~and Rainfall Data..................................June, 321~~
Bartow, Edward. Latest Method of Sewage Disposal........I., Apr., 153 Sewage d
Blake, Edmund M. Service for the Society.................I., Apr., 171
~~Boston and Maine R. R., Federal Valuation of..............D., Feb., 71~~
~~Bowl, The Yale. *Thomas C. Atwood*.........................I., June, 231~~
Bridge Design, Minor Problems in. ~~*L. M. Hastings*~~ ....I., Feb., 59 Bri
Bridge, The Portland. *Eugene E. Pettee*..................I., Dec., 487 Bri
Brooks, Fred. Pan-American Use of the Metric System. Feb., 65; D., I., Sept., 377 — ?
~~*Brown, H. Whittemore.* The Groined Arch as a Means of Concrete Floor Construction...............................I., Oct., 439~~

Cambridge, Ohio, Reconstruction of Water Works. *W. J. Sherman.* May, 189 W
~~*Chandler, E. F.*~~ Discussion of Power Estimates from Stream Flow and Rainfall Data..................................~~June, 313~~
Channel, Effect of, on Stream Flow. *N. C. Grover*..........I., Nov., 465
Cleaning Lock Gate Trackways at Charles River Dam. *Edward C. Sherman*.......................................I., Mar., 121 Dam
Cohill, A. A. The Dorchester Tunnel......................I., May, 179

PAGE

Commercial Fertilizer Industry in the United States. *Lester W. Tucker* ....I., Sept., 331
Concrete Floor Construction, The Groined Arch as a Means of. *H. Whittemore Brown* ....I., Oct., 439
Concrete, Reinforced, Slide Rule for Design of. *E. F. Rockwood.* I., May, 207
Concrete, Reinforced, Special Methods of Design....D., Jan., 29
Cunningham, W. J. Discussion of Valuation of the Boston and Maine R. R....Feb., 71

Determining the Weight of Stone in Vessels. *A. S. Ackerman*...May, 203
~~Dorchester Tunnel~~, The. *A. A. Cohill*....I., May, 179

Sanitation
Eaton, *Harold I.* Mosquito Extermination in Panama and New Jersey. I., June, 259
Effect of Channel on Stream Flow. *N. C. Grover*....I., Nov., 465
Ellsworth, Emory Alexander, Memoir of....Nov., 480

F*arrington, W. R.* Sand and Oil Roads and Surfaces. Highway
Feb., 43; D., May, 225
Federal Valuation of the Boston and Maine R. R.....D., Feb., 71
Fertilizer Industry in the United States. *L. W. Tucker*....I., Sept., 331
Fletcher, A. B. Discussion of Sand and Oil Roads and Surfaces...May, 209

Gerrish, John Herbert, Memoir of....May, 229
Glines, E. S. Discussion of Power Estimates from Stream Flow and Rainfall Data....June, 317
Gow, Charles R. Address at the Annual Meeting....Apr., 125
Discussion of Water Supply of Salem....Jan., 19
Groined Arch as a Means of Concrete Floor Construction. *H. Whittemore Brown*....I., Oct., 439
Grover, N. C. Effect of Channel on Stream Flow....I., Nov., 465

H*ammersley, W. P.* Discussion of Sand and Oil Roads and Surfaces. May, 217
Hastings, L. M. Minor Problems in a Highway Bridge Design. I., Feb., 59
~~Hawkes~~, Levi Gowen, Memoir of....Jan., 38
Hayes, H. V. Discussion of Valuation of the Boston and Maine R. R. Feb., 75
Hazen, Allen. Discussion of Power Estimates from Stream Flow and Rainfall Data....June, 299
Herschel, Clemens. Discussion of Power Estimates from Stream Flow and Rainfall Data....I., June, 303

PAGE

~~*Hosmer, Geo. L.* Discussion of Transforming Latitude and Longitude into Plane Coördinates . . . . I., Sept., 370~~
Howard, John L. Joint Mortar Exposed to Tidal Currents . . . . . . Jan., 27
Humphreys, Alexander C. Reform and Regulation. June, 271; D., Sept., 425 — ?

~~*Irwin, J. C.* Discussion of Valuation of Boston and Maine R. R.~~ . . Feb., 73

~~*Jackson, D. C.* Discussion of Reform and Regulation . . . . . . Sept., 405~~
Jaques, Samuel Foster, Memoir of . . . . Nov., 481
~~Jenney, Walter, Memoir of . . . . Jan., 39~~
Johnson, Wm. S. Water Supply of Salem, Mass. . . . . I., Jan., 1
~~Joint Mortar Exposed to Tidal Currents. *J. L. Howard* . . . . . . Jan., 27~~

~~Keppler, Theodore Louis, Memoir of . . . . Jan., 37~~
Keyes, John M. Discussion of Sand and Oil Roads and Surfaces . . May, 224

~~Latest Method of~~ Sewage Disposal. ~~*Edward Bartow*~~ . . . . I., Apr., 153
Latitude and Longitude, A Method of Transforming, into Plane Coordinates. *Sturgis H. Thorndike* . . . . I., Sept., 363; D., Sept., 370
~~Leavitt, Erasmus Darwin, Memoir of . . . . June, 329~~
~~*Lorente, M. J.* Discussion of Some Special Methods of Reinforced Concrete Design . . . . Jan., 32~~

Memoirs of Deceased Members:
  Emory Alexander Ellsworth . . . . Nov., 480
  John Herbert Gerrish . . . . May, 229
  Levi Gowen Hawkes . . . . Jan., 38
  Samuel Foster Jaques . . . . Nov., 481
  Walter Jenney . . . . Jan., 39
  Theodore Louis Keppler . . . . Jan., 37
  Erasmus Darwin Leavitt . . . . June, 329
  Edmund K. Turner . . . . Nov., 477
  Charles W. Ross . . . . Nov., 483
Method of Transforming Latitude and Longitude into Plane Coördinates. *Sturgis H. Thorndike* . . . . I., Sept., 363; D., Sept., 370
~~Metric System, Pan-American Use of. *Fred. Brooks.* Feb., 65; D., I., Sept., 377~~
Minor Problems ~~in a Highway Bridge Design. *L. M. Hastings.*~~ I., Feb., 59
Monkey Cart. *E. F. Rockwood* . . . . I., Mar., 123
~~Mortar Exposed to Tidal Currents. *John L. Howard*~~ . . . . Jan., 27

PAGE

Mosquito Extermination in Panama and New Jersey. *Harold I. Eaton.* I., June, 259

New Jersey, Mosquito Extermination in Panama and. *Harold I. Eaton.* I., June, 259

Page, Logan Walter. Discussion of Sand and Oil Roads and Surfaces. May, 214
~~Pan-American Use of the~~ Metric System. *Fred. Brooks.* Feb., 65; D., I., Sept., 377
Panama and New Jersey, Mosquito Extermination in. *Harold I. Eaton.* I., June, 259
Panama Canal, The Spillways of. *Edward C. Sherman* . . . . I., Apr., 135
Parker, Alfred W. Discussion of Pan-American Use of Metric System. Sept., 396
Pettee, Eugene E. The Portland Bridge . . . . I., Dec., 487
Philadelphia, The Sewage Disposal Problem of. *W. L. Stevenson.* I., Sept., 345
~~*Pierce, C. H.*~~ Discussion of Power Estimates from Stream Flow and Rainfall Data . . . . June, 314
Plane Coördinates, A Method of Transforming Latitude and Longitude into. *Sturgis H. Thorndike* . . . . I., Sept., 363; D., Sept., 370
Portland Bridge. *Eugene E. Pettee* . . . . I., Dec., 487
Power Estimates from Stream Flow and Rainfall Data. *Dana M. Wood.* I., Mar., 77; D., June, 299

Rainfall Data, Power Estimates from Stream Flow and. *Dana M. Wood* . . . . I., Mar., 77; D., June, 299
Reconstruction of the Water Works, Cambridge, Ohio. *W. J. Sherman* . . . . May, 189
Reform and Regulation. *Alexander C. Humphreys.* June, 271; D., Sept., 405
Reinforced Concrete Design, Special Methods of . . . . D., Jan., 29
Reinforced Concrete Design, Slide Rules for. *E. F. Rockwood.* I., May, 207
Roads and Surfaces, Sand and Oil. *W. R. Farrington.* Feb., 43; D., May, 209
Rockwood, E. F. A Monkey Cart . . . . I., Mar., 123
  Slide Rules for Reinforced Concrete Design . . . . I., May, 207
Ross, Charles W., Memoir of . . . . Nov., 483
Rourke, L. K. Discussion of Spillways of the Panama Canal . . . . . Apr., 151

Salem, Mass., Water Supply of. *W. S. Johnson* . . I., Jan., 1; D., Jan., 19

PAGE

Sand and Oil Roads and Surfaces. *W. R. Farrington.* Feb., 43; D., May, 209
Service for the Society. *Edmund M. Blake* . . . . I., Apr., 171
Sewage Disposal, The Latest Method of. *Edward Bartow* . . . . . I., Apr., 153
Sewage Disposal Problem Confronting the City of Philadelphia. *W. L. Stevenson* . . . . I., Sept., 345
Sherman, Charles W. Early Types of Turbines . . . . I., Jan., 23 Power pl
Sherman, Edward C. Cleaning Lock Gate Trackways at the Charles River Dam . . . . I., Mar., 121
  Spillways of the Panama Canal . . . . I., Apr., 135; D., Apr., 151
Sherman, W. J. The Reconstruction of the Cambridge, Ohio, Water Works . . . . May, 189
Slide Rules for Reinforced Concrete Design. *E. F. Rockwood* . I., May, 207
Snow, J. P. Discussion of Reform and Regulation . . . . Sept., 421
Special Methods of Reinforced Concrete Design . . . . D., Jan., 29
Spillways of the Panama Canal. *Edward C. Sherman.* I., Apr., 135; D., Apr., 151
Stearns, F. P. Discussion of Reform and Regulation . . . . Sept., 410
Stevenson, W. L. The Sewage Disposal Problem Confronting the City of Philadelphia . . . . I., Sept., 345
Stone in Vessels, Determination of Weight of. *A. S. Ackerman* . . May, 203
Stream Flow and Rainfall Data, Power Estimates from. *Dana M. Wood* . . . . I., Mar., 77; D., June, 299
~~Stream Flow, Effect of Channel on. *N. C. Grover* . . . . I., Nov., 465~~

Thompson, S. E. Discussion of Reform and Regulation . . . . Sept., 424
Thorndike, Sturgis H. A Method of Transforming Latitude and Longitude into Plane Coördinates . . . . I., Sept., 363; D., Sept., 370
Tidal Currents, Joint Mortar Exposed to. *John L. Howard* . . . . . Jan., 27
Transforming Latitude and Longitude into Plane Coördinates. *Sturgis H. Thorndike* . . . . I., Sept., 363; D., Sept., 370
Tucker, Lester W. The Commercial Fertilizer Industry in the United States . . . . I., Sept., 331
Tunnel, The Dorchester. *A. A. Cohill* . . . . I., May, 179
Turbines, Early Types of. *C. W. Sherman* . . . . I., Jan., 23
Turner, Edmund K., Memoir of . . . . Nov., 477

U*pham, C. M.* Discussion of Sand and Oil Roads and Surfaces . . May, 212

Valuation of the Boston and Maine R. R. . . . . D., Feb., 71 —?

Water Supply of Salem, Mass. *W. S. Johnson* . . I., Jan., 1; D., Jan., 19
~~Water Wheels, Early Types of. *C. W. Sherman* . . . . I., Jan., 23~~

PAGE
Water Works, Reconstruction of Cambridge, Ohio. *W. J. Sherman.* May, 189
Weed, A. R. Discussion of Reform and Regulation..........Sept., 418
Weight of Stone in Vessels, Determining the. *A. S. Ackerman*..May, 203
Weston, Robert Spurr. Discussion of Pan-American Use of the Metric System...Sept., 393
Wood, Dana M. Power Estimates from Stream Flow and Rainfall Data...............................I., Mar., 77; D., June, 324
Worcester, J. R. Discussion of Some Special Methods of Reinforced Concrete Design.......................................Jan., 29

Yale Bowl, The. *Thomas C. Atwood*.....................I., June, 231

Vol. III DECEMBER, 1916 No. 10

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

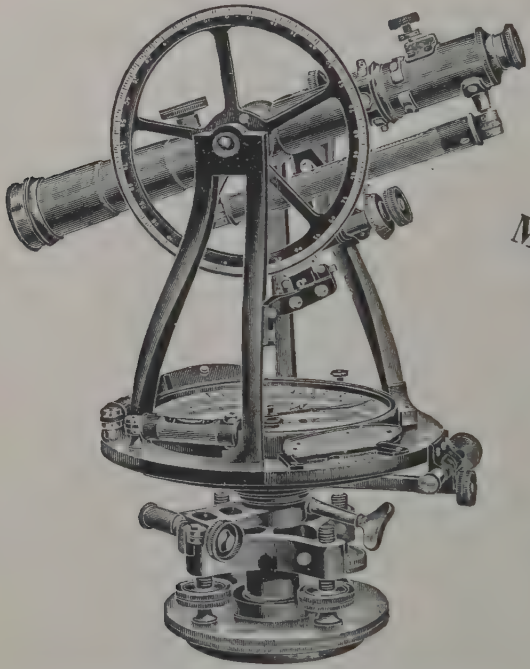
INDEX TO ADVERTISERS.

Page
A. B. See Electric Elevators, 111 Devonshire St., Boston....... XVI
Aberthaw Construction Co., 8 Beacon St., Boston............. XV
Adams, H. S., 108 Ames Building, Boston, Mass............... IV
Aspinwall & Lincoln, 3 Hamilton Pl., Boston................ IV
Associated Architects Printing & Supply Co., 144 Congress St., Boston.. XVII
Bay State Dredging Co., Ltd., 247 Atlantic Ave., Boston..... X
Bishop, J. W., & Co., 683 Atlantic Ave., Boston............... XI
Blair, Isaac, & Co., Inc., 433 Harrison Ave., Boston.......... XI
Bond, Harold L., Co., 383 Atlantic Ave., Boston............. XIV
Buss, Edward A., 85 Water St., Boston...................... IV
Coleman Bros., 1 Marginal St., Chelsea....................... XIV
Detroit Graphite Co., 94 Milk St., Boston.................. XVII
Dixon Crucible Co., Jersey City, N. J....................... XVII
Eastern Bridge and Structural Co., Worcester............. XVI
Fay, Spofford & Thorndike, 308 Boylston St., Boston........ IV
Fort Hill Press, 176 High St., Boston...................... XVI
Fuller, George W., 170 Broadway, New York................ IV
Gow, The Charles R., Co., 166 Devonshire St., Boston....... XIII
Hall, John G., & Co., 114 State St., Boston................. XVII
Harrington, Ephraim, 20 Pemberton Sq., Boston............. IV
Hern, J. L., Engineering Co., 149 Pearl St., Boston.......... IV
Hersey Mfg. Co., South Boston.............................. XVIII
Holbrook, Cabot & Rollins, Corpn., 6 Beacon St., Boston.... VII
Holzer, U., 25 Bromfield St., Boston......................... X
Hughes, Edward F., 8 Oliver St., Boston.................... XVII
Jackson, D. C. & Wm. B., 248 Boylston St., Boston........... IV
Jonsberg, F. F., Co., 733 Old South Building, Boston.......... XI
Ledder & Probst, 56 Franklin St., Boston.................... XIV
Main, Charles T., 201 Devonshire St., Boston................ III
Makepeace, B. L., 12 Bromfield St., Boston.................. II
Metcalf & Eddy, 14 Beacon St., Boston...................... IV
Moss, Charles E. Co., 38 Broad St., Boston.................. XIV
New England Bureau of Tests, Inc., 12 Pearl St., Boston.... V
New England Sand & Gravel Co., West Peabody, Mass...... VIII
Old Corner Book Store, 27 Bromfield St., Boston............ XVII
Palmer, John E., 1012 Old South Bldg., Boston.............. XVII

SURVEYING INSTRUMENTS

FOR SALE, FOR RENT, REPAIRED

Second Hand Instruments Bought and Sold



LEVELING RODS

MEASURING TAPES

SLIDE RULES

TEE SQUARES

Importer of and Dealer in

DRAWING MATERIALS and INSTRUMENTS

A full line of

DRAWING ROOM FURNITURE

BLACK LINE and BLUE PRINTS

B. L. MAKEPEACE

387 WASHINGTON ST. BOSTON, MASS.

Automobile and Messenger Service to all parts of the city

	Page
Pennsylvania Cement Co., 161 Devonshire St., Boston	xi
Perrin, Seamans & Co., 57 Oliver St., Boston	xvii
Rideout, Chandler & Joyce, 178 High St., Boston	xiv
Rockport Granite Co., Rockport, Mass.	vi
Simpson Bros. Corpn., 166 Devonshire St., Boston	vi
Smith, B. F., & Co., 60 Federal St., Boston	xiv
Spaulding Print Paper Co., 44 Federal St., Boston	xiii
Stone & Webster, 147 Milk St., Boston	ix
Thompson, Sanford E., 141 Milk St., Boston	iv
Thorpe, Lewis D., 201 Devonshire St., Boston	iv
Tucker, Edward A., Co., 683 Atlantic Ave., Boston	vi
Waldo Brothers, Boston	x
Warren Brothers Co., 142 Berkeley St., Boston	xii
Warren Foundry and Machine Co., 111 Broadway, New York	viii
Weston, Robert Spurr, 14 Beacon St., Boston	v
Wheeler, Charles D., 65 Kilby St., Boston	xiii
Whitman & Howard, 220 Devonshire St., Boston	v
Wood, R. D., & Co., Philadelphia	viii
Worcester, J. R., & Co., 79 Milk St., Boston	v

PROFESSIONAL CARDS

CHAS. T. MAIN

ENGINEER

201 Devonshire Street, Boston, Mass.
Rooms 817-833

Plans and Specifications for the erection and equipment or reorganization of textile mills and other industrial plants, including steam and water-power plants

H. S. ADAMS

Consulting Engineer

108-9 AMES BUILDING
BOSTON, MASS.

ASPINWALL & LINCOLN

Civil Engineers

3 HAMILTON PLACE
BOSTON

EDWARD A. BUSS

Mill Architect and Consulting Engineer

New Construction, Rearrangements, Electrical Equipment, Economy of Operation

85 Water St., Boston, Mass.

FAY, SPOFFORD & THORNDIKE

Consulting Engineers

BRIDGES AND OTHER STRUCTURES OF STEEL AND MASONRY. FOUNDATIONS. RIVER AND HARBOR WORKS

FREDERIC H. FAY CHARLES M. SPOFFORD
STURGIS H. THORNDIKE

308 Boylston Street, Boston, Mass.

GEORGE W. FULLER

M. Am. Soc. C. E. M. Am. Inst. Cons. E.

Consulting Hydraulic Engineer and Sanitary Expert

JAMES R. McCLINTOCK

Water Supply and Purification, Sewerage and Drainage, Disposal of Sewage and Refuse, Investigation of Epidemics, Public Utilities Valuations, Supervision of Construction and Operation.

170 Broadway, New York, N. Y.

EPHRAIM HARRINGTON

M. Am. Soc. C. E.

Consulting and Advisory Engineer

EXAMINATIONS, ESTIMATES AND REPORTS.
Private and Municipal Improvements and Developments.
PRELIMINARY SURVEYS, DESIGNS AND SUPERVISION.

20 Pemberton Sq. Boston

J. L. HERN ENGINEERING CO.

Consulting Mechanical Engineering

Heating, Ventilating and Mechanical Equipment

Tel. Fort Hill { 3013 / 4974
149 PEARL STREET
BOSTON, MASS.

D. C. & WM. B. JACKSON

Consulting Engineers

FOR ELECTRIC AND ALLIED PROPERTIES

CHICAGO
Harris Trust Bldg.

BOSTON
248 Boylston St.

METCALF & EDDY

Leonard Metcalf Harrison P. Eddy
Charles W. Sherman Wm. T. Barnes
Almon L. Fales

14 Beacon Street
Boston, Mass.

Harris Trust Building
Chicago, Ill.

Water Supply and Sewerage

SANFORD E. THOMPSON

M. Am. Soc. C. E. M. Am. Soc. M. E.

Consulting Engineer

Design of Steel and Reinforced Concrete; Review of Plans; Estimates and Appraisals; Tests of Cement and Concrete; Organization of Construction and Industrial Work.

NEWTON HIGHLANDS
MASS.

141 MILK ST.
BOSTON

LEWIS D. THORPE

Civil and Sanitary Engineer

Water Works, Sewerage and Sewage Disposal

Supervision of Construction and Operation

201 Devonshire Street
BOSTON, MASS.

WESTON & SAMPSON

ROBERT SPURR WESTON G. A. SAMPSON

Laboratory for the Analysis of Water, Sewage, Filtering Materials, etc., Design, Inspection and Supervision of Water Purification and Sewage Disposal Plants.

14 BEACON STREET, BOSTON, MASS.

WHITMAN & HOWARD

Civil Engineers

(Established in 1869)

220 Devonshire Street Room 504
BOSTON

J. R. Worcester E. E. Pettee G. H. Brazer
MEMBERS OF AM. SOC. C. E.

J. R. WORCESTER & CO.

Consulting and Designing Engineers

Bridges Foundations
Steel and Reinforced Concrete Construction

79 MILK STREET, BOSTON

Cement Testing Laboratory at Waltham, Mass.

NEW ENGLAND BUREAU OF TESTS, Inc.

Inspecting Engineers and Chemists

Herbert L. Sherman, President
Joshua L. Miner, First Vice-President
A. B. Bellows, Second Vice-President
Wm. F. Zimmermann, Secretary

Tests and inspection of Iron and Steel, Cement and Concrete Materials, Road Materials, Pipe, Wire and Machinery of all kinds.

Chemical Analyses and Research.

Our own laboratories and inspectors at all important points.

12 Pearl Street
BOSTON

'Phone, Fort Hill 3038

SIMPSON BROS. CORPORATION

TRADE MARK REG.
LAID BY SIMPSON BROS.
CORPORATION
166 DEVONSHIRE ST.
BOSTON

ENGINEERS AND CONTRACTORS
FOR
REINFORCED CONCRETE
CONSTRUCTION

ROCK ASPHALT FLOORS — GRANOLITHIC FLOORS.
SIDEWALKS, CURBING, STEPS, BUTTRESSES, ETC.
SIMBROCO CONCRETE STONE BUILDING TRIM.
HASSAM CONCRETE STREET PAVEMENT.

ROCKPORT GRANITE

permanently resists all action of Sea Water

It is an undeniable fact that chemical changes take place in the cement of CONCRETE construction exposed for any number of years to sea water, changes that are certainly not for the better.

No changes take place in Rockport Granite. It is permanent, and it is impermeable; and these FACTS are beyond question. The same facts apply to masonry work of every description — Rockport Granite is the ONE material of PERMANENCY.

A combination of Quality and Low Price is offered in Rockport Granite, full details of which will be supplied upon request. Write.

ROCKPORT GRANITE CO. - RocKport, Mass.
C. HARRY ROGERS, Treas. and Gen'l Mgr.
BRANCHES:
New York, 21 Park Row, Represented by F. E. Foster. Chicago, Chamber of Commerce Bldg., Represented by J. D. Duffy. Boston, 31 State St. Winnipeg, Canada, N. J. Dinnen Co.

EDWARD A. TUCKER COMPANY

Concrete Engineers

Designs and Estimates Submitted *Structural Steel*
Concrete Reinforcement *Fabrication and Erection*

ESSEX BUILDING - 683 ATLANTIC AVENUE, BOSTON
Opp. South Station
Direct Mill Connections Warehouse, Cambridge Shop, Camden, N. J.
Telephone, Oxford 4670

Holbrook, Cabot & Rollins Corp'n

Contractors

Heavy Masonry and Concrete Construction, Deep Foundations

6 BEACON STREET BOSTON, MASS.

Charles Building, 331 Madison Avenue
New York, N. Y.

JAMES W. ROLLINS, President
FREDERICK HOLBROOK, Vice-Pres., and Gen'l Manager
THOMAS B. BRYSON, Second Vice-President
WILLIAM S. PATTEN, Treasurer

Use washed and graded sand and gravel for concrete work.

It insures permanency, and reduces labor cost.

Illustration shows first operation in handling.

We are equipped to make prompt shipment on large contracts.

DEPENDABLE SERVICE
WINTER OR SUMMER

NEW ENGLAND SAND & GRAVEL CO.
WEST PEABODY, MASS.
'Phone, Peabody 244-M

WARREN FOUNDRY AND MACHINE CO.

111 Broadway, New York City

MANUFACTURERS OF

Cast Iron Gas and Water Pipe

ALSO ALL KINDS OF FLANGE PIPE AND SPECIAL CASTINGS

R. D. Wood & Company,
Philadelphia, Pa.

Engineers **Iron Founders** **Machinists**

Pumping Engines, Centrifugal Pumping Machinery, Gas Producer Power Plants (and big installations) Gas Holders, Cast Iron Pipe, Valves and Hydrants, Water and Gas Works Appliances.

STONE & WEBSTER

FINANCE public utility developments.

BUY AND SELL securities.

DESIGN steam power stations, hydro-electric developments, transmission lines, city and interurban railways, gas plants, industrial plants and buildings.

CONSTRUCT either from our own designs or from designs of other engineers or architects.

REPORT on public utility properties, proposed extensions or new projects.

MANAGE railway, light, power and gas companies.

NEW YORK BOSTON CHICAGO

Bay State Dredging & Contracting Co.

CONTRACTORS

River and Harbor Improvements
Sea Walls, Breakwaters, Concrete and General
Construction Work

247 Atlantic Ave., Boston, Mass.

Telephones { Fort Hill 1689
Fort Hill 1690

JAMES E. CASHMAN, Treas. and Gen. Mgr.
GORHAM H. WHITNEY, President
DAVID J. WHITE, Secretary

WALDO BROTHERS

BOSTON, MASS.

NEW ENGLAND AGENTS FOR

ATLAS PORTLAND CEMENT
AKRON SEWER PIPE

U. HOLZER,

BOOK-BINDER

25 Bromfield St., Boston, Mass.

ESTABLISHED 1870.

All kinds of Books bound and repaired.
Maps and Charts mounted.
Portfolios, Scrap Books, Blank Books, etc., made to order.
Lettering in Gold; Paper-Splitting; Inlaying; etc.
Photographs Mounted on Card or Paper without Cockling.

Telephone and Elevator

F. F. JONSBERG CO.

Engineering Construction
Switch Cell Construction

733 OLD SOUTH BUILDING
BOSTON

THE EXTREME HIGH QUALITY OF
PENNSYLVANIA PORTLAND CEMENT
MAKES ITS USE ESSENTIAL WHERE
WORK OF THE HIGHEST CLASS IS DESIRED

PENNSYLVANIA CEMENT CO.

NEW YORK OFFICE
30 East 42d St.

BOSTON OFFICE
161 Devonshire St.

NEW YORK
101 Park Avenue

BOSTON
683 Atlantic Avenue

J. W. BISHOP COMPANY
General Contractors

PROVIDENCE
317 Butler Exchange

WORCESTER
109 Foster Street

GEO. A. BLAIR
L. L. STREET
W. O. WELLINGTON

ISAAC BLAIR & CO., Inc., General Contractors

Shoring and Moving Buildings a Specialty

433 Harrison Avenue, BOSTON

The Popularity of BITULITHIC is Founded on Quality

It is economy to pave your streets with the best material at first, and have a construction which will meet with all the demands of the present auto traffic.

Cities which have used BITULITHIC are constantly repeating contracts for it, as they have found it is cheaper to get the best bituminous construction (BITULITHIC) in the beginning, rather than experiment on inferior forms, — thus saving the city money in the end, and having a street that is good at all times.

BOSTON, MASS.
Bitulithic Pavement. Columbia Road (at Hewins Street). Laid over old Macadam, 1915

BITULITHIC

is an asset — It is an investment — not a speculation

There is no guesswork. Nothing but quality in the construction of BITULITHIC. It is constructed under scientific methods, and under close laboratory supervision.

The best of stone and bituminous cement is used, which makes BITULITHIC

Unequaled in reputation Unquestioned in quality Unrivaled in popularity

The Pavement of prestige, — BITULITHIC

Do not hesitate, — investigate BITULITHIC

BITULITHIC has the merits that a first-class pavement should have. — Everything to gain. — Nothing to lose.

Insist on BITULITHIC

WARREN BROTHERS COMPANY

Executive Offices, BOSTON, MASS.

District Offices

NEW YORK, N. Y.
ROCHESTER, N. Y.
PHOENIX, ARIZ.
UTICA, N. Y.
CHICAGO, ILL.
LOS ANGELES, CAL.
WINNIPEG, MAN.
RICHMOND, VA.
TORONTO, ONT.
ST. LOUIS, MO.
PORTLAND, ORE.
NASHVILLE, TENN.
VANCOUVER, B. C.
MONTREAL, P. Q.

THE CHARLES R. GOW COMPANY

Contractors for Engineering Construction

No. 166 DEVONSHIRE STREET

BOSTON, MASS.

CHARLES D. WHEELER

Insurance

Telephone 5231 Main

65 KILBY STREET, BOSTON

Liability, Fire, Life, Accident, Marine and Automobile Insurance

ALSO CONTRACTORS' BONDS AT LOWEST RATES CONSISTENT WITH ABSOLUTE SECURITY

Spaulding Print Paper Co.

BLUE PRINTERS

Blue Prints made from profile and other long tracings in continuous lengths. Small or large orders furnished in the quickest possible time.

A full line of DRAWING MATERIALS in stock at lowest Prices

44 FEDERAL STREET, BOSTON, MASS.

TELEPHONE, MAIN 4103 or 1390

PROMPT SERVICE GOOD QUALITY FAIR PRICES

HAROLD L. BOND COMPANY

HAROLD L. BOND, Pres. GEORGE S. HEDGE, Treas.

TOOLS AND MACHINERY

For All Forms of Construction Work

Boilers, Engines, Pumps, Dump Cars, Derrick Fittings, Blocks, Rock Drills, Dynamite, Blasting Supplies, Iron and Steel

RAILROAD, MILL AND CONTRACTORS' SUPPLIES

383-391 ATLANTIC AVENUE : : : : : BOSTON

Long Distance Telephone

LEDDER & PROBST, Inc.

56 Franklin Street, Boston, Mass.

Surveying Instruments

REPAIRING

BLUE AND BLACK PRINTS

Drawing Materials

RIDEOUT, CHANDLER & JOYCE

Engineers and Piping Contractors

178 HIGH STREET - BOSTON, MASS.

Steam Specialties, Engineers' Supplies

Piping of All Kinds Furnished or Erected

CHARLES E. MOSS CO.

Blue Printing and Blue Print Paper

Engineering and Drafting Supplies

38 Broad Street - Boston

TEL. MAIN 3295 and 2751

C. D. Kirkpatrick, *Mgr.* S. P. Gates, *Asst. Mgr.*

B. F. SMITH & CO., INC.

Established 1878

ARTESIAN AND DRIVEN WELLS

FOUNDATION BORINGS

Engineers and Contractors for Municipal and Private Water Works

Office: 1st NATIONAL BANK BUILDING,

60 FEDERAL STREET, BOSTON, MASS

COLEMAN BROS.

General Contractors

Main Office

1 Marginal St., Chelsea

Boston Address

166 Devonshire St.

THIS SPACE
IS
FOR SALE

Machine Shop Extension, Fore River Shipbuilding Corporation, Quincy, Mass.

"Builders—Not Bidders"

This building was erected on our regular cost-plus-profit basis — a basis of mutual confidence — of value received and satisfaction given. And the result could not but be right.

That is the way we build factories — power houses — dams — warehouses — of reinforced concrete and brick and steel.

ABERTHAW CONSTRUCTION CO.

Contracting Engineers Specializing in Concrete

8 BEACON STREET (6-39) **BOSTON**

SAMUEL USHER
ESTABLISHED 1881
The Fort Hill Press
A Modern Plant
Accuracy and Excellence
BOOK-MAGAZINE-CATALOG
LAW & JOB PRINTING.
176 TO 184 HIGH STREET,
FORT HILL SQUARE
TWO MINUTES' WALK FROM ROWE'S WHARF STATION OF BOSTON ELEVATED RAILWAY
BOSTON, MASS

A. B. SEE
ELECTRIC
ELEVATORS
Established 1883

ELECTRIC ELEVATORS OF ALL TYPES

OFFICES
New York
Boston
Hartford
Jersey City
Philadelphia
Washington
Baltimore
Cleveland
Montreal
Toronto

WORKS
Jersey City
New Jersey
Montreal
Canada

BOSTON OFFICE
Minot Building
111 Devonshire St.

EASTERN BRIDGE
— AND —
STRUCTURAL CO.
Worcester, Massachusetts,
For Prices on all Classes of
STEEL AND IRON WORK.
WE DESIGN AND MANUFACTURE
ROOF TRUSSES, GIRDERS, COLUMNS, STAIRS
AND FIRE ESCAPES FOR BUILDINGS . . . .
FOOT BRIDGES, HIGHWAY BRIDGES, RAILROAD BRIDGES
We Carry a Large Stock of
I-BEAMS, PLATES AND ANGLES
Can Make Quick Deliveries. Send in Your Inquiries.

PERRIN, SEAMANS & CO.

Machinery, Tools and Supplies
FOR
Construction Work

57 OLIVER STREET, BOSTON

EDWARD F. HUGHES
Artesian and Driven Wells
for
Manufacturing, Public or Private
Water Supply
954 Oliver Building, 8 Oliver Street, Boston, Mass.
TEL. 1633 MAIN

SCIENTIFIC BOOKS
AND PERIODICALS

THE OLD CORNER BOOK STORE
27-29 Bromfield Street
BOSTON, MASS.

DETROIT GRAPHITE COMPANY
PAINT MAKERS
Special Penstock and Standpipe Paint
"Superior Graphite Paint" for Steel
Bridges and Buildings
94 Milk St., Boston, Mass.

Made for C. E. draughtsmen, and in 17 degrees.
DIXON'S
ELDORADO
DIXON'S ELDORADO HB
"the master drawing pencil"
Write on your letterhead for samples.
JOSEPH DIXON CRUCIBLE COMPANY
JERSEY CITY, N. J.

JOHN G. HALL & CO.
114 STATE STREET, BOSTON
=PILING=

JOHN E. PALMER
Contracting Engineer
Contractor for Sewers, Water Works,
Concrete Bridges, Concrete
Foundations, etc.
Room 1012, Old South Building
Boston, Mass.
Telephone, Fort Hill 1731

Associated Architects Printing & Supply Co.
144 CONGRESS STREET, BOSTON

BLUE, BLACK AND VANDYKE PRINTING ON PAPER OR LINEN
BLACK ON WHITE REPRODUCTION PROCESS—ANY COLOR
DRAWING MATERIALS AND SUPPLIES

TELEPHONE, FORT HILL 4013

APPROVAL

HERSEY DETECTOR METER

The Hersey Detector Meter has been accepted for eleven years in 3", 4", 6", 8", 10" and 12" sizes without any restrictions or conditions of any kind by every Insurance Company, Stock and Mutual, doing business in the United States, and by the Water Departments and Water Companies in more than 500 Cities and Towns for use on over 3,000 Fire Services protecting nearly $2,000,000,000. worth of Insured Property.

HERSEY MANUFACTURING COMPANY

BOSTON COLUMBUS, O. SAN FRANCISCO
NEW YORK PHILADELPHIA LOS ANGELES
CHICAGO ATLANTA PORTLAND, ORE.

SPECIAL COMMITTEES — Continued

ON SOCIAL ACTIVITIES

HENRY A. SYMONDS, Chairman

DAVID A. AMBROSE
EDWIN R. OLIN
CHARLES H. EGLEE
ALFRED E. BURTON
DANA M. WOOD
GEORGE A. SAMPSON

ON PAPERS AND PROGRAM

RICHARD A. HALE, Chairman ex officio

LEWIS E. MOORE
STURGIS H. THORNDIKE
EDMUND M. BLAKE
EDWARD H. ROCKWELL
GEORGE E. RUSSELL
ROBERT SPURR WESTON
CHARLES B. BREED
S. EVERETT TINKHAM

RATES FOR ADVERTISEMENTS

For one year — 10 issues

One page	$75.00
One-half page	40.00
One-quarter page	25.00
One-sixth page	17.50
One-eighth page	14.00
One-twelfth page	10.00

Last page, 50 per cent. additional.

For further information, or for contract forms, address

EDWARD C. SHERMAN, Editor,
6 Beacon Street, Boston.

SAMUEL USHER
BOSTON